# SECOND QUARTERLY
# AMBIENT AIR MONITORING REPORT
# LIVINGSTON RAIL YARD

Submitted to:

**Montana Department of Health**
**and Environmental Sciences**
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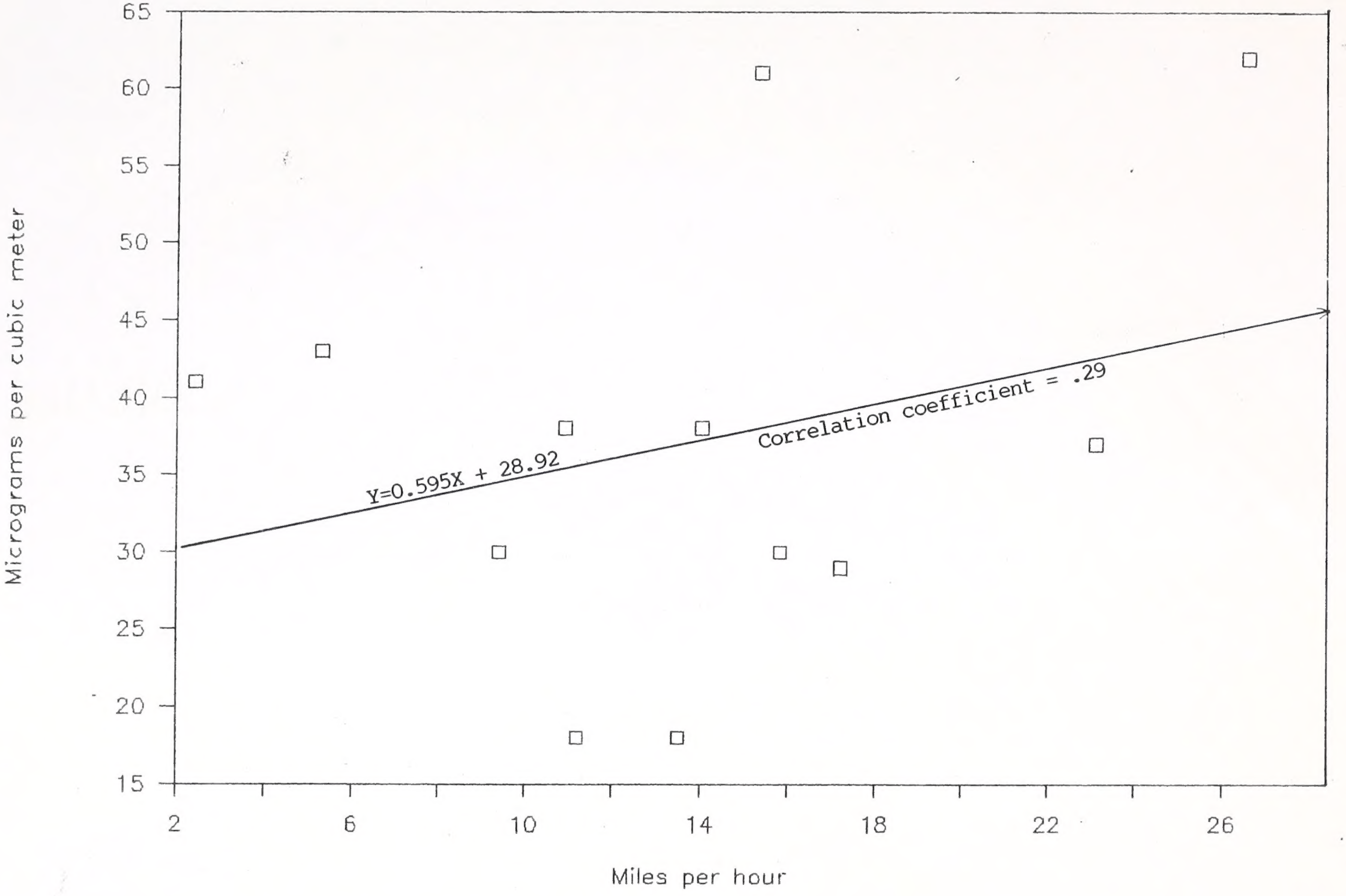
**Submittal Date: June 7, 1991**

ENVIROCON, INC.

FIGURE 6.0 - SECOND QUARTERLY AMBIENT AIR MONITORING REPORT



TSP vs WIND SPEED

# 1.0 INTRODUCTION

This document presents the results of Burlington Northern Railroad's (BNRR) ambient air monitoring investigations, conducted by Envirocon, Inc., for the Livingston rail yard project, in Livingston, Montana. The purpose of ambient air monitoring is to assess the impact of existing site contamination and remedial activities on ambient air quality. Envirocon will submit quarterly ambient air monitoring reports to the Montana Department of Health and Environmental Sciences until the monitoring program is complete. Ambient air monitoring data collection began on November 10, 1990. This is the second quarterly report, which represents the period between January 1, 1991 and March 31, 1991.

BNRR purchased air monitoring equipment and through Envirocon is responsible for its daily operations. Bison Engineering, Inc. provides assistance by conducting audits, performing laboratory work, and assisting with quarterly-report data preparation.

Envirocon designed and operates the network in accordance with Section 14.4 of the Interim Remedial Measures Work Plan (IRMWP), as specified by the Montana Department of Health and Environmental Sciences (MDHES).

## 2.0 NETWORK CONFIGURATION

### 2.1 Monitoring Locations - General

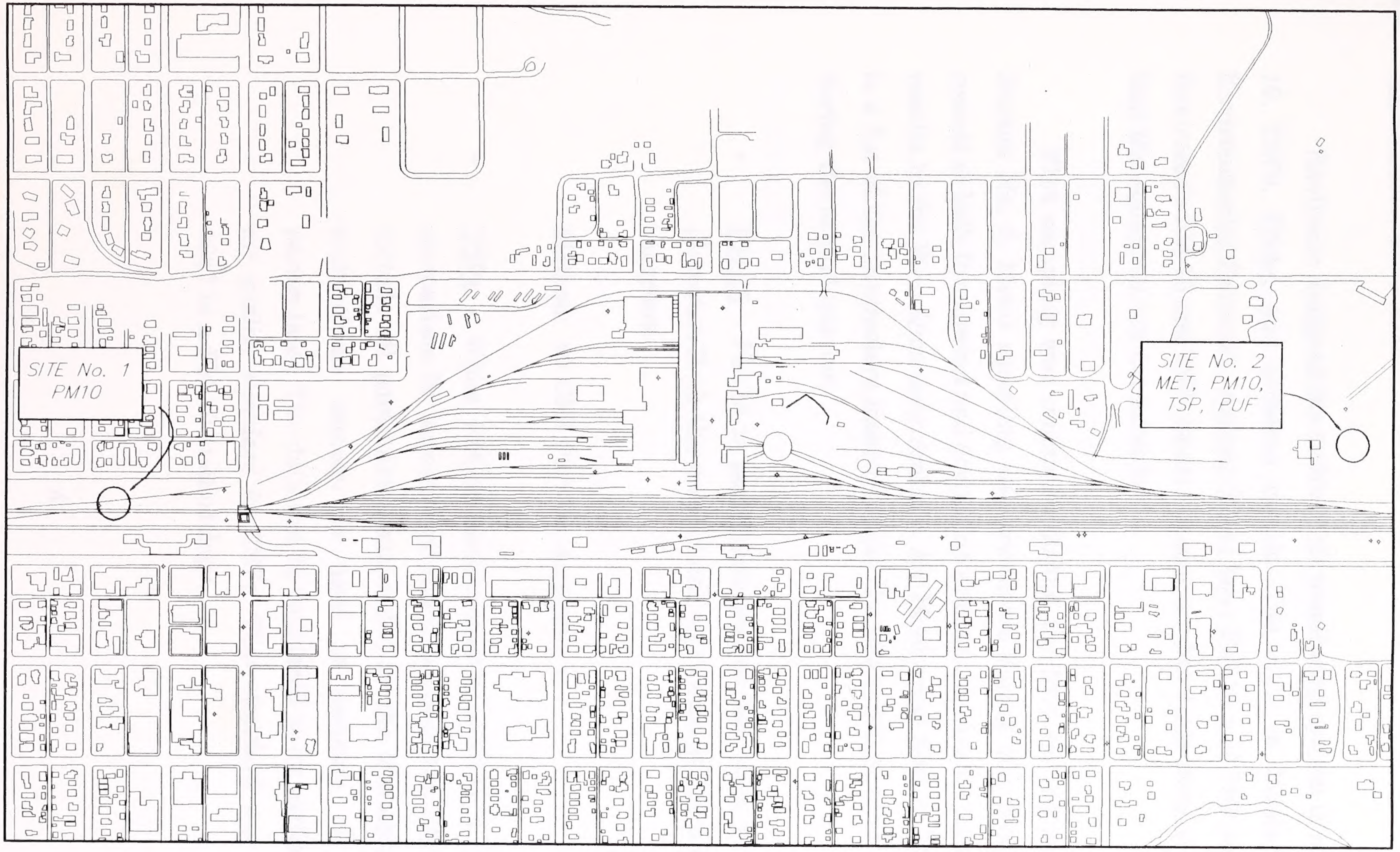
Envirocon established an ambient air monitoring network near the Livingston rail yard to measure upwind and downwind air quality during remedial activities. Requirements for this network are outlined in Section 14.4 of the IRMWP. The network consists of an upwind station (Station No. 1) and a downwind station (Station No. 2). Each station contains a PM-10 air monitoring instrument. Station No. 2 also contains meteorological equipment, a total suspended particulate (TSP) sampler, and a polyurethane foam (PUF) sampler (presently not in use) designed to measure polynuclear aromatic hydrocarbons (PNAs). PUF sampling and metal measurements were only required during the first six sampling events of the first quarter.

Station No. 1 measures ambient air quality upwind of all remedial activities. Station No. 2 is located to measure worst-case ambient air impacted by remediation activities. In addition, ambient air at Station No. 2 is impacted by current railyard operations. Figure 1.0 shows the locations of both stations. The coordinate locations of these sites are shown on Table 1.0.

**Table 1.0 - Ambient Air Monitoring Locations**

| Station No. | Universal Time Meridian (UTM) | UTM | East Latitude | North Latitude |
|---|---|---|---|---|
| 1 | 334050 | 5056410 | $45^0$ 38' 36" | $113^0$ 7' 46" |
| 2 | 335360 | 5057520 | $45^0$ 39' 13" | $113^0$ 6' 47" |

UTM ZONE = 12



BURLINGTON NORTHERN

**ENVIROCON, INC.**

AMBIENT AIR
MONITORING REPORT

SUBMITTED: JUNE 3, 1991

140101

UPWIND & DOWNWIND AMBIENT
AIR MONITORING LOCATIONS

5/31/91

FIGURE 1.0

AutoCAD FILE: DM1.DWG

## 2.2 Monitoring Parameters

Envirocon designed the ambient air monitoring system to measure PM-10, TSPs, PNAs, and airborne metals. The state of Montana and the Environmental Protection Agency (EPA) have PM-10 and TSP standards. Envirocon's PM-10 and TSP results are compared to these standards to ensure that the standards are not exceeded.

PNA sampling was conducted during the first six sample rounds at Station No. 2. Metal sampling was conducted during the first six sample rounds at both the upwind and downwind stations. Envirocon presented these results in the First Quarterly Ambient Air Monitoring Report. The following is a list of the parameters measured and the methodology used for analysis during the second quarter:

- PM-10 - PM-10 is particulate matter less than 10 microns in diameter. Both the upwind and downwind stations have PM-10 samplers.

  Method: 40 CFR Part 50, Appendix J.

- TSPs - While PM-10 measurements provide a health-basis comparison for human exposure to particulates, PM-10 does not include all particulates suspended in the atmosphere. A TSP high-volume sampler is used to measure all suspended particulates. The data can be compared to an earlier, out-dated air quality standard for TSPs. That standard was changed in 1987 to a PM-10 methodology.

Method: Sections 1.11.1, 2.1.1, and 2.1.1.1 of the Montana Air Quality Assurance Manual

- <u>Meteorology</u> - Envirocon constructed a meteorological tower at Station No. 2 in order to assess what meteorological events may lead to the increase or decrease of ambient air pollutants. The station recorded wind speed, wind direction, temperature, and wind sigma (standard deviation of the wind direction).

  Method: Anemometer cup, wind vane, thermocouple, and computer data acquisition system (Ambient Monitoring Guidelines for Prevention of Significant Deterioration [PSD], Section 6, EPA, EPA-450/4-87-007).

## 2.3 Monitoring Frequency

The monitoring frequency for each parameter is shown on Table 2.0.

**Table 2.0 - Ambient Monitoring Frequency**

| | |
|---|---|
| PM-10 | Once every 6 days, 24-hour duration<br>Station No. 1 and Station No. 2 |
| TSP | Once every 6 days, 24-hour duration<br>Station No. 2 only |
| Meteorology | Continuous sampling<br>Hourly data analysis<br>Site No. 2 only |

# 3.0 DATA SUMMARY

## 3.1 PM-10

Envirocon collected 14 PM-10 samples at each station between January 1 and March 31, 1991. The mean PM-10 values for this period were 19 ug/m$^3$ at Station No. 1 and 15 ug/m$^3$ at Station No. 2. The peak PM-10 reporting values for Stations 1 and 2 were 40 ug/m$^3$ and 28 ug/m$^3$, respectively. These values are compared against the Montana ambient air quality standards on Table 3.0.

**Table 3.0 - PM-10 Results Versus Ambient Standards**

| | Standard | Station No. 1 | Station No. 2 |
|---|---|---|---|
| Mean | 50* | 19 | 15 |
| Peak | 150** | 40 | 28 |

Units: ug/m$^3$
* Annual mean
** Not to be exceeded more than once per year

Complete PM-10 data and summary statistics are provided in Appendix A. The statistics include monthly means, yearly mean to-date, geometric mean and standard deviation. Appendix B contains the results of calibrations, audits and precision checks.

## 3.2 TSPs

Envirocon operated one TSP sampler at the downwind monitoring station. Envirocon collected 15 TSP samples between January 1 and May 31, 1991. The mean TSP value for this period was 36 ug/m$^3$ and the peak TSP value was 62 ug/m$^3$. These values are compared against the Montana's outdated ambient air quality standards on Table 4.0.

**Table 4.0 - TSP Results Versus Outdated Ambient Standards**

| | Standard | Station No. 2 |
|---|---|---|
| Mean | 75* | 36 |
| Peak | 260** | 62 |

Units: ug/m$^3$
* Annual mean
** Not to be exceeded more than once per year

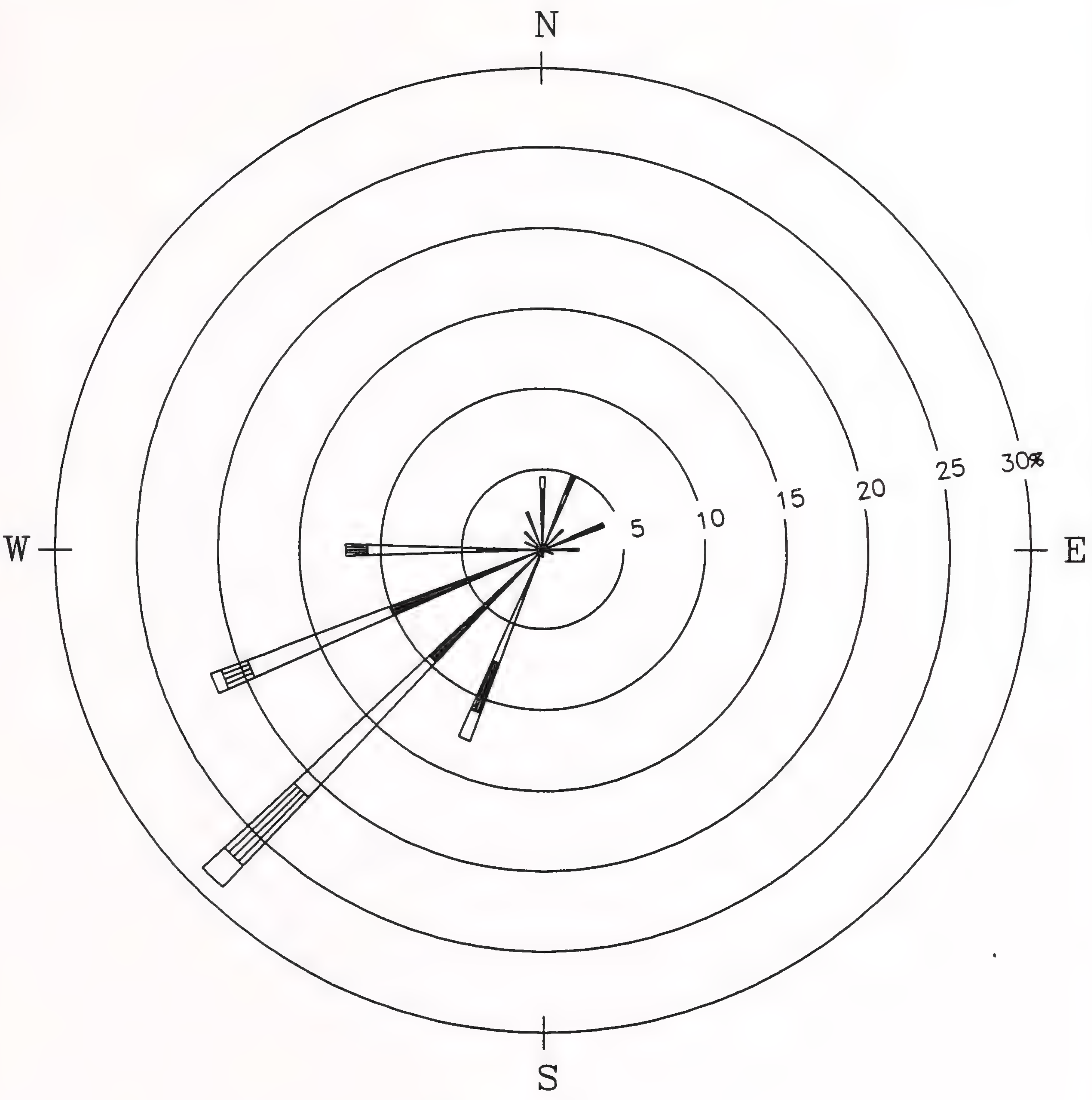
Complete TSP data and summary statistics are in Appendix A. The statistics include monthly means, yearly mean to-date, geometric mean and standard deviation. Appendix B provides quality control information, including calibration and auditing results.

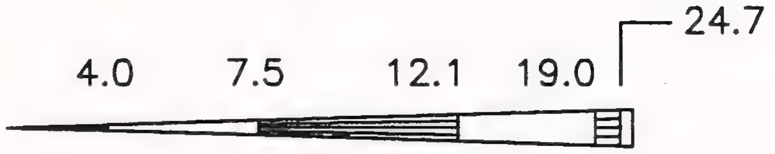
## 3.3 Meteorology

The meteorological station at the downwind site measures wind speed, wind direction, temperature, and wind sigma. Overall data recovery for the meteorological system was good during the second quarter of operation. Data from 14 days in January and 4 days in March is missing due to a corrupted data file. This data is not recoverable.

Between January 1 and March 31, 1991, the average wind speed was 13.2 miles per hour, the resultant wind direction was 236 degrees, and the percentage of calm hours was 0.0 percent. The maximum temperature during this period was 64 $^0$F, the minimum temperature was -11 $^0$F, and the average temperature was 35 $^0$F.

Appendix A contains a complete list of the meteorological information for wind speed, direction, temperature, and sigma. Appendix A also contains monthly and seasonal wind-frequency distribution data. Windroses are shown on Figures 2.0 through 5.0.





Wind Speed Class Boundaries
(Miles/Hour)

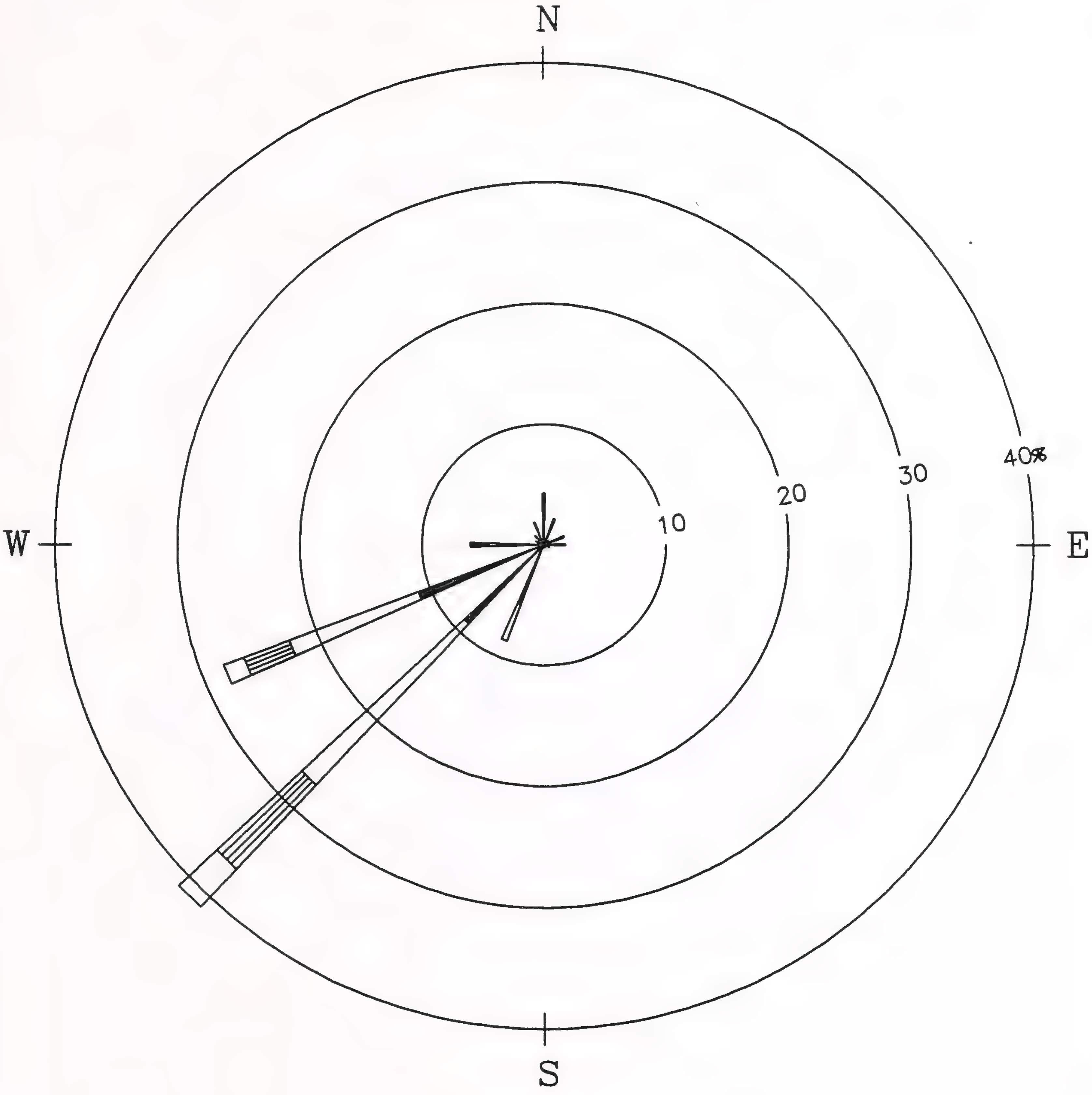
NOTES:
Diagram of the Frequency of Occurrence for each Wind Direction. Wind Direction is the Direction From Which the Wind is Blowing.

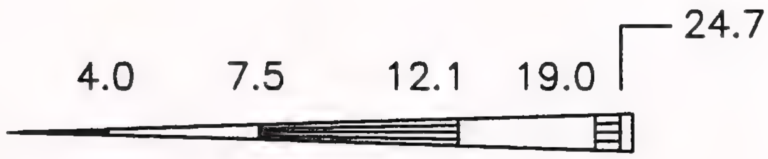
# WINDROSE

Livingston – Downwind
PERIOD: 1 QTR 1991

FIGURE 2.0

Bison
Engineering





Wind Speed Class Boundaries
(Miles/Hour)

NOTES:
Diagram of the Frequency of Occurrence for each Wind Direction. Wind Direction is the Direction From Which the Wind is Blowing.

# WINDROSE

Livingston – Downwind
PERIOD: Jan. 1991

FIGURE 3.0

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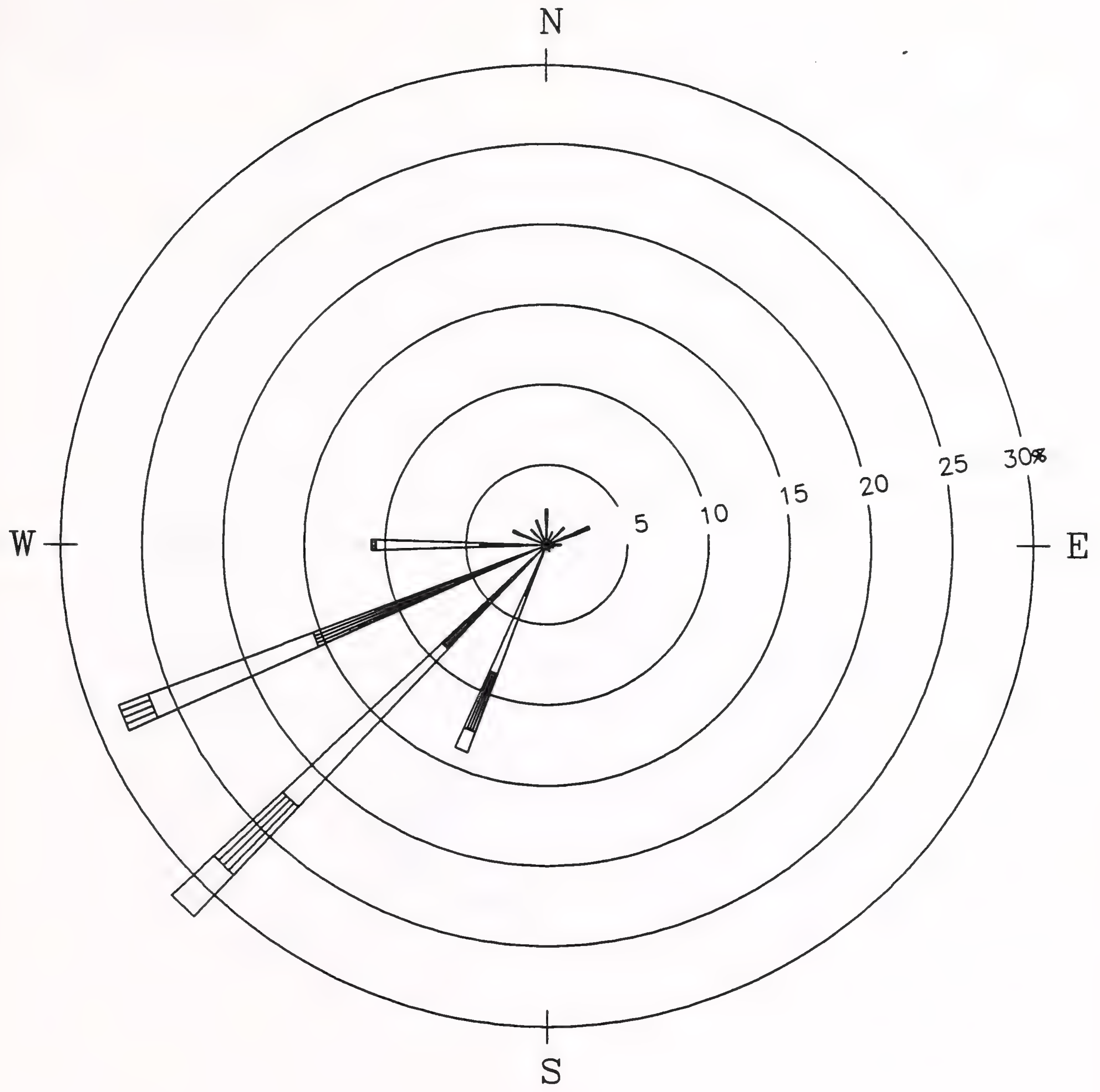
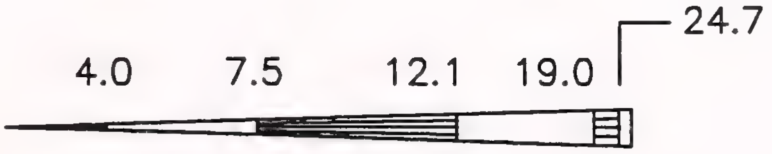
Engineering





Wind Speed Class Boundaries
(Miles/Hour)

NOTES:
Diagram of the Frequency of
Occurrence for each Wind Direction.
Wind Direction is the Direction
From Which the Wind is Blowing.

# WINDROSE

Livingston – Downwind
PERIOD: Feb. 1991

FIGURE 4.0

Bison
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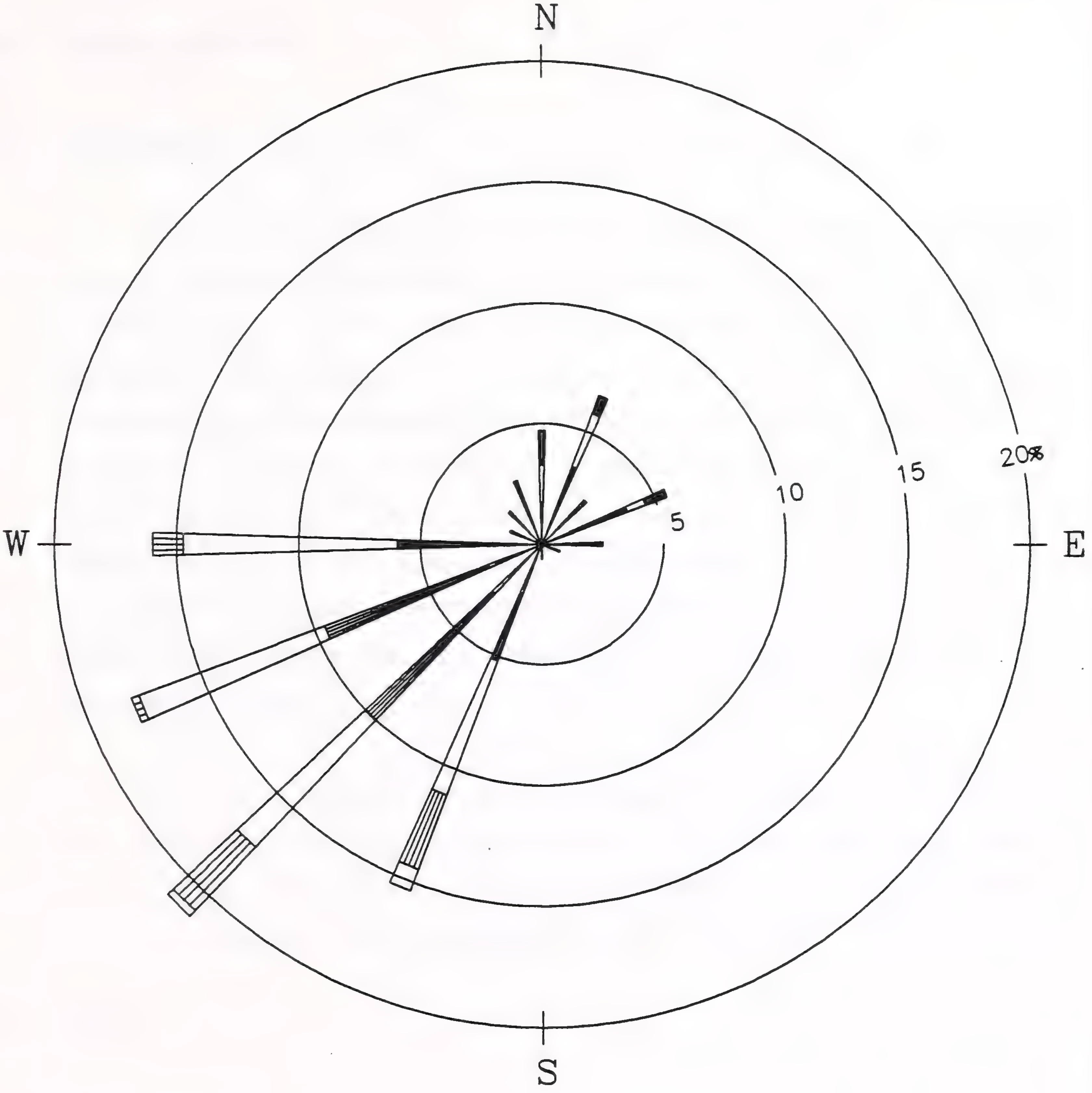

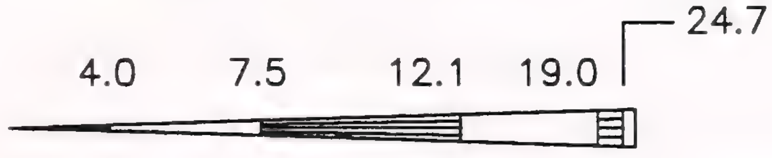

Wind Speed Class Boundaries
(Miles/Hour)

NOTES:
Diagram of the Frequency of
Occurrence for each Wind Direction.
Wind Direction is the Direction
From Which the Wind is Blowing.

# WINDROSE

Livingston – Downwind
PERIOD: Mar. 1991

FIGURE 5.0

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## 4.0 DATA ANALYSIS

### 4.1 Introduction

The purpose of the ambient air monitoring network is to assess the impacts of existing site contamination and remedial activities on ambient air quality. However, the ambient air monitoring network can not distinguish between sources associated with previous site contamination and sources associated with current industrial operations. The first step of assessment is to measure parameters which could be reasonably expected to enter the ambient atmosphere. These parameters, defined by Section 14.4 of the IRMWP, include PM-10, TSPs, metals, and PNAs. The second step of assessment is to compare these results with previously established ambient air quality standards. The final step of assessment is to compare the results with background results.

This report does not provide the investigative details for each of the above activities; however, it does assess some of the characteristics of the results to date. The following is a discussion of PM-10 and TSP results. Metal and PNA results were discussed in the first quarterly report.

### 4.2 PM-10

Section 3.0 of this report provided a comparison between the collected PM-10 values and the Montana and EPA ambient air quality standards. The results indicate values well below these standards. All information collected to date indicates that the standards will not be exceeded. Envirocon compared the upwind and downwind PM-10 data and the results of this comparison are provided on Table 7.0.

## Table 7.0 - Upwind/Downwind PM-10 Comparison

| SAMPLE DATE | UPWIND | DOWNWIND | DIFFERENCE |
|---|---|---|---|
| 1/6/91 | N/A | 17 | |
| 1/12/91 | 14 | N/A | |
| 1/18/91 | 13 | 13 | 0 |
| 1/24/91 | 15 | 9 | 6 |
| 1/30/91 | 22 | 24 | -2 |
| 2/5/91 | 15 | 12 | 3 |
| 2/11/91 | 19 | 18 | 1 |
| 2/17/91 | 9 | 14 | -5 |
| 2/23/91 | 15 | 13 | 2 |
| 3/1/91 | 19 | 8 | 11 |
| 3/7/91 | 12 | 15 | -3 |
| 3/14/91 | 39 | 28 | 11 |
| 3/19/91 | 40 | 20 | 20 |
| 3/25/91 | 13 | 8 | 5 |
| 3/31/91 | 16 | 15 | 1 |

Units: $ug/m^3$

Paired and unpaired t-tests were applied to the data to assess whether there is enough evidence to reject the null hypothesis that the two means are the same. The results of these tests are summarized on Table 8.0.

## Table 8.0

## Summary Statistics

| | | |
|---|---|---|
| UPWIND | Mean:<br>Std Dev:<br>No. of Samples: | 18.64<br>9.07<br>14 |
| DOWNWIND | Mean:<br>Std Dev:<br>No. of Samples: | 15.29<br>5.60<br>14 |
| DIFFERENCE | Mean:<br>Std Dev:<br>No. of Samples: | 3.85<br>6.58<br>13 |

## Comparison of Upwind and Downwind Means

Paired Difference t-test:

t = Mean/(S/(n)^.5)          where s = std. dev.

t = 2.11

Critical t (95%) = 2.17

Unpaired t-test:

t = (mean1 - mean2)/(S*(1/n+1/n)^.5)   where s = pooled std. dev.

t = 1.21

Critical t (95%) = 2.12

Since both t values fall within their respective 95-percent two-tailed confidence intervals (as defined by the critical t values), Envirocon concludes that not enough evidence exists to reject the null hypothesis. Therefore, there

is no difference in the mean and mean-difference PM-10 values between the two monitoring sites.

## 4.3 TSP

The results of TSP sampling to date indicate values well below the outdated ambient air quality standard. These results are shown in Section 3.0. The IRMWP requires that Envirocon compare three TSP samples where the wind speed exceeded 15 knots (17 mph) during sample collection. The purpose of this comparison is to determine whether TSP values increase during higher wind speeds. Two sample days during the previous quarter exhibited wind speeds exceeding 17 miles per hour and those results were examined in the First Quarterly Ambient Air Monitoring Report. The results of current TSP sampling are compared against the daily mean wind speed for the respective sampling days on Table 9.0.

## Table 9.0 - TSP Versus Wind Speed TSP

| SAMPLE DATE | (ug/m^3) | (mph) |
|---|---|---|
| 1/18/91 | 37 | 23.1 |
| 1/24/91 | 18 | 11.2 |
| 1/30/91 | 62 | 26.5 |
| 2/5/91 | 30 | 15.8 |
| 2/11/91 | 61 | 15.3 |
| 2/17/91 | 38 | 10.9 |
| 2/23/91 | 30 | 9.4 |
| 3/7/91 | 29 | 17.2 |
| 3/14/91 | 41 | 2.4 |
| 3/19/91 | 43 | 5.3 |
| 3/25/91 | 18 | 13.5 |
| 3/31/91 | 38 | 14 |

Figure 6.0 shows a graph of TSP versus wind speed data. The least-squares regression line is plotted on the figure. The correlation coefficient is 0.29. From a statistical viewpoint, this indicates that about 8% of the data fits the linear model well. This means that there is little or no relation between wind speed and TSP concentrations.

# APPENDIX A
# DATA RESULTS

# PM10 Data

(Appendix A)

# Bison Engineering Inc

Helena, MT 59601

## *PM10 Particulate Summary*

1991 Site & Area: 1111 3

Upwind Site Livingston, MT Envirocon

(Values are in Micrograms per Cubic Meter)

| Day | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | - | - | 19 | - | - | - | - | - | - | - | - | - |
| 2 | - | - | - | - | - | - | - | - | - | - | - | - |
| 3 | - | - | - | - | - | - | - | - | - | - | - | - |
| 4 | - | - | - | - | - | - | - | - | - | - | - | - |
| 5 | - | 15 | - | - | - | - | - | - | - | - | - | - |
| 6 | - | - | - | - | - | - | - | - | - | - | - | - |
| 7 | - | - | 12 | - | - | - | - | - | - | - | - | - |
| 8 | - | - | - | - | - | - | - | - | - | - | - | - |
| 9 | - | - | - | - | - | - | - | - | - | - | - | - |
| 10 | - | - | - | - | - | - | - | - | - | - | - | - |
| 11 | - | 19 | - | - | - | - | - | - | - | - | - | - |
| 12 | 14 | - | - | - | - | - | - | - | - | - | - | - |
| 13 | - | - | - | - | - | - | - | - | - | - | - | - |
| 14 | - | - | 39 | - | - | - | - | - | - | - | - | - |
| 15 | - | - | - | - | - | - | - | - | - | - | - | - |
| 16 | - | - | - | - | - | - | - | - | - | - | - | - |
| 17 | - | 9 | - | - | - | - | - | - | - | - | - | - |
| 18 | 13 | - | - | - | - | - | - | - | - | - | - | - |
| 19 | - | - | 40 | - | - | - | - | - | - | - | - | - |
| 20 | - | - | - | - | - | - | - | - | - | - | - | - |
| 21 | - | - | - | - | - | - | - | - | - | - | - | - |
| 22 | - | - | - | - | - | - | - | - | - | - | - | - |
| 23 | - | 15 | - | - | - | - | - | - | - | - | - | - |
| 24 | 15 | - | - | - | - | - | - | - | - | - | - | - |
| 25 | - | - | 13 | - | - | - | - | - | - | - | - | - |
| 26 | - | - | - | - | - | - | - | - | - | - | - | - |
| 27 | - | - | - | - | - | - | - | - | - | - | - | - |
| 28 | - | - | - | - | - | - | - | - | - | - | - | - |
| 29 | - | - | - | - | - | - | - | - | - | - | - | - |
| 30 | 22 | - | - | - | - | - | - | - | - | - | - | - |
| 31 | - | - | 16 | - | - | - | - | - | - | - | - | - |
| No. | 4 | 4 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Max | 22 | 19 | 40 | | | | | | | | | |
| Avg | 16 | 15 | 23 | | | | | | | | | |

# Bison Engineering Inc

Helena, MT 59601

## *PM10 Particulate Summary*

1991 Site & Area: 1111 4

Downwind Site Livingston, MT Envirocon

(Values are in Micrograms per Cubic Meter)

| Day | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | - | - | 8 | - | - | - | - | - | - | - | - | - |
| 2 | - | - | - | - | - | - | - | - | - | - | - | - |
| 3 | - | - | - | - | - | - | - | - | - | - | - | - |
| 4 | - | - | - | - | - | - | - | - | - | - | - | - |
| 5 | - | 12 | - | - | - | - | - | - | - | - | - | - |
| 6 | 17 | - | - | - | - | - | - | - | - | - | - | - |
| 7 | - | - | 15 | - | - | - | - | - | - | - | - | - |
| 8 | - | - | - | - | - | - | - | - | - | - | - | - |
| 9 | - | - | - | - | - | - | - | - | - | - | - | - |
| 10 | - | - | - | - | - | - | - | - | - | - | - | - |
| 11 | - | 18 | - | - | - | - | - | - | - | - | - | - |
| 12 | - | - | - | - | - | - | - | - | - | - | - | - |
| 13 | - | - | - | - | - | - | - | - | - | - | - | - |
| 14 | - | - | 28 | - | - | - | - | - | - | - | - | - |
| 15 | - | - | - | - | - | - | - | - | - | - | - | - |
| 16 | - | - | - | - | - | - | - | - | - | - | - | - |
| 17 | - | 14 | - | - | - | - | - | - | - | - | - | - |
| 18 | 13 | - | - | - | - | - | - | - | - | - | - | - |
| 19 | - | - | 20 | - | - | - | - | - | - | - | - | - |
| 20 | - | - | - | - | - | - | - | - | - | - | - | - |
| 21 | - | - | - | - | - | - | - | - | - | - | - | - |
| 22 | - | - | - | - | - | - | - | - | - | - | - | - |
| 23 | - | 13 | - | - | - | - | - | - | - | - | - | - |
| 24 | 9 | - | - | - | - | - | - | - | - | - | - | - |
| 25 | - | - | 8 | - | - | - | - | - | - | - | - | - |
| 26 | - | - | - | - | - | - | - | - | - | - | - | - |
| 27 | - | - | - | - | - | - | - | - | - | - | - | - |
| 28 | - | - | - | - | - | - | - | - | - | - | - | - |
| 29 | - | - | - | - | - | - | - | - | - | - | - | - |
| 30 | 24 | - | - | - | - | - | - | - | - | - | - | - |
| 31 | - | - | 15 | - | - | - | - | - | - | - | - | - |
| No. | 4 | 4 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Max | 24 | 18 | 28 | | | | | | | | | |
| Avg | 16 | 14 | 16 | | | | | | | | | |

Bison Engineering Inc.
Helena, MT 59601

## *SUMMARY STATISTICS FOR THE PM10 PARTICULATE DATA*

*1991*

Upwind Site Livingston, MT Envirocon

| Site # | Min | Max | 2nd Max | # > 150 | Arith. Mean | Arith. Std Dev | Geo. Mean | Geo. Std Dev | Total # Obs. |
|---|---|---|---|---|---|---|---|---|---|
| 3 | 9 | 40 | 39 | 0 | 19 | 9 | 17 | 1.5 | 14 |
| 4 | 8 | 28 | 24 | 0 | 15 | 6 | 14 | 1.5 | 14 |

# TSP Data

(Appendix A)

# Bison Engineering Inc

Helena, MT 59601

## *Total Suspended Particulate Summary*

1991 Site & Area: 1111 4

Downwind Site Livingston, MT Envirocon

(Values are in Micrograms per Cubic Meter)

| Day | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | - | - | 20 | - | - | - | - | - | - | - | - | - |
| 2 | - | - | - | - | - | - | - | - | - | - | - | - |
| 3 | - | - | - | - | - | - | - | - | - | - | - | - |
| 4 | - | - | - | - | - | - | - | - | - | - | - | - |
| 5 | - | 30 | - | - | - | - | - | - | - | - | - | - |
| 6 | 33 | - | - | - | - | - | - | - | - | - | - | - |
| 7 | - | - | 29 | - | - | - | - | - | - | - | - | - |
| 8 | - | - | - | - | - | - | - | - | - | - | - | - |
| 9 | - | - | - | - | - | - | - | - | - | - | - | - |
| 10 | - | - | - | - | - | - | - | - | - | - | - | - |
| 11 | - | 61 | - | - | - | - | - | - | - | - | - | - |
| 12 | 43 | - | - | - | - | - | - | - | - | - | - | - |
| 13 | - | - | - | - | - | - | - | - | - | - | - | - |
| 14 | - | - | 41 | - | - | - | - | - | - | - | - | - |
| 15 | - | - | - | - | - | - | - | - | - | - | - | - |
| 16 | - | - | - | - | - | - | - | - | - | - | - | - |
| 17 | - | 38 | - | - | - | - | - | - | - | - | - | - |
| 18 | 37 | - | - | - | - | - | - | - | - | - | - | - |
| 19 | - | - | 43 | - | - | - | - | - | - | - | - | - |
| 20 | - | - | - | - | - | - | - | - | - | - | - | - |
| 21 | - | - | - | - | - | - | - | - | - | - | - | - |
| 22 | - | - | - | - | - | - | - | - | - | - | - | - |
| 23 | - | 30 | - | - | - | - | - | - | - | - | - | - |
| 24 | 18 | - | - | - | - | - | - | - | - | - | - | - |
| 25 | - | - | 18 | - | - | - | - | - | - | - | - | - |
| 26 | - | - | - | - | - | - | - | - | - | - | - | - |
| 27 | - | - | - | - | - | - | - | - | - | - | - | - |
| 28 | - | - | - | - | - | - | - | - | - | - | - | - |
| 29 | - | - | - | - | - | - | - | - | - | - | - | - |
| 30 | 62 | - | - | - | - | - | - | - | - | - | - | - |
| 31 | - | - | 38 | - | - | - | - | - | - | - | - | - |
| No. | 5 | 4 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Max | 62 | 61 | 43 | | | | | | | | | |
| Avg | 39 | 40 | 32 | | | | | | | | | |

Bison Engineering Inc.
Helena, MT 59601

## *SUMMARY STATISTICS FOR THE TSP PARTICULATE DATA*

*1991*

Downwind Site Livingston, MT Envirocon

| Site # | Min | Max | 2nd Max | # > 150 | Arith. Mean | Arith. Std Dev | Geo. Mean | Geo. Std Dev | Total # Obs. |
|---|---|---|---|---|---|---|---|---|---|
| 4 | 18 | 62 | 61 | 0 | 36 | 13 | 34 | 1.5 | 15 |

# Meteorological Data
## (Appendix A)

# BISON ENGINEERING INC.
## HELENA, MONTANA

JANUARY 1991

## *** WIND SPEED SUMMARY ***

| DAY | HOURS 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | AVG. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 4 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 5 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 6 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 7 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 8 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 9 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 10 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 11 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 12 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 13 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 14 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 15 | - | - | - | - | - | - | - | - | - | 9.0 | 11.0 | 12.0 | 13.0 | 16.0 | 14.0 | 11.0 | 13.0 | 12.0 | 11.0 | 8.0 | 5.0 | 7.0 | 9.0 | 8.0 | 10.6 |
| 16 | 4.0 | 9.0 | 9.0 | 9.0 | 8.0 | 10.0 | 9.0 | 9.0 | 11.0 | 13.0 | 14.0 | 14.0 | 20.0 | 17.0 | 17.0 | 17.0 | 14.0 | 13.0 | 12.0 | 13.0 | 12.0 | 13.0 | 12.0 | 11.0 | 12.1 |
| 17 | 13.0 | 15.0 | 15.0 | 17.0 | 18.0 | 18.0 | 15.0 | 16.0 | 14.0 | 13.0 | 14.0 | 12.0 | 11.0 | 14.0 | 14.0 | 17.0 | 14.0 | 15.0 | 19.0 | 17.0 | 16.0 | 19.0 | 17.0 | 19.0 | 15.5 |
| 18 | 21.0 | 23.0 | 23.0 | 20.0 | 21.0 | 25.0 | 21.0 | 18.0 | 24.0 | 27.0 | 24.0 | 22.0 | 24.0 | 25.0 | 26.0 | 20.0 | 23.0 | 19.0 | 20.0 | 22.0 | 27.0 | 29.0 | 29.0 | 22.0 | 23.1 |
| 19 | 18.0 | 16.0 | 11.0 | 18.0 | 16.0 | 10.0 | 9.0 | 4.0 | 7.0 | 10.0 | 9.0 | 14.0 | 16.0 | 18.0 | 16.0 | 16.0 | 12.0 | 9.0 | 9.0 | 7.0 | 9.0 | 12.0 | 13.0 | 15.0 | 12.3 |
| 20 | 14.0 | 14.0 | 13.0 | 14.0 | 16.0 | 13.0 | 12.0 | 11.0 | 10.0 | 11.0 | 13.0 | 13.0 | 13.0 | 13.0 | 14.0 | 15.0 | 13.0 | 10.0 | 8.0 | 10.0 | 11.0 | 13.0 | 12.0 | 14.0 | 12.5 |
| 21 | 13.0 | 15.0 | 14.0 | 13.0 | 15.0 | 17.0 | 17.0 | 16.0 | 16.0 | 20.0 | 19.0 | 19.0 | 20.0 | 19.0 | 20.0 | 21.0 | 20.0 | 23.0 | 22.0 | 20.0 | 21.0 | 21.0 | 21.0 | 20.0 | 18.4 |
| 22 | 16.0 | 16.0 | 14.0 | 14.0 | 17.0 | 20.0 | 18.0 | 15.0 | 15.0 | 13.0 | 13.0 | 11.0 | 13.0 | 14.0 | 14.0 | 12.0 | 10.0 | 9.0 | 12.0 | 10.0 | 7.0 | 5.0 | 5.0 | 9.0 | 12.6 |
| 23 | 15.0 | 9.0 | 4.0 | 13.0 | 11.0 | 5.0 | 5.0 | 6.0 | 2.0 | 3.0 | 6.0 | 13.0 | 11.0 | 11.0 | 11.0 | 11.0 | 10.0 | 13.0 | 15.0 | 17.0 | 20.0 | 21.0 | 21.0 | 18.0 | 11.3 |
| 24 | 17.0 | 18.0 | 19.0 | 17.0 | 14.0 | 11.0 | 10.0 | 8.0 | 6.0 | 9.0 | 11.0 | 9.0 | 9.0 | 14.0 | 12.0 | 13.0 | 12.0 | 16.0 | 15.0 | 10.0 | 8.0 | 3.0 | 5.0 | 3.0 | 11.2 |
| 25 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 4.0 | 4.0 | 12.0 | 12.0 | 14.0 | 15.0 | 11.0 | 10.0 | 9.0 | 6.0 | 7.0 | 8.0 | 11.0 | 8.0 | 10.0 | 8.0 | 7.0 | 8.0 | 10.0 | 7.9 |
| 26 | 14.0 | 15.0 | 14.0 | 14.0 | 17.0 | 17.0 | 16.0 | 15.0 | 14.0 | 18.0 | 16.0 | 15.0 | 12.0 | 16.0 | 23.0 | 18.0 | 15.0 | 16.0 | 16.0 | 15.0 | 15.0 | 16.0 | 19.0 | 14.0 | 15.8 |
| 27 | 15.0 | 13.0 | 16.0 | 14.0 | 10.0 | 17.0 | 21.0 | 18.0 | 21.0 | 22.0 | 17.0 | 14.0 | 23.0 | 18.0 | 20.0 | 20.0 | 17.0 | 18.0 | 12.0 | 17.0 | 23.0 | 23.0 | 18.0 | 13.0 | 17.5 |
| 28 | 5.0 | 16.0 | 15.0 | 14.0 | 15.0 | 17.0 | 17.0 | 21.0 | 23.0 | 23.0 | 20.0 | 20.0 | 16.0 | 16.0 | 17.0 | 12.0 | 13.0 | 11.0 | 13.0 | 6.0 | 2.0 | 2.0 | 10.0 | 12.0 | 14.0 |
| 29 | 13.0 | 15.0 | 19.0 | 19.0 | 24.0 | 23.0 | 24.0 | 27.0 | 25.0 | 24.0 | 23.0 | 23.0 | 22.0 | 21.0 | 25.0 | 27.0 | 26.0 | 32.0 | 25.0 | 24.0 | 20.0 | 23.0 | 22.0 | 24.0 | 22.9 |
| 30 | 26.0 | 21.0 | 22.0 | 25.0 | 25.0 | 25.0 | 25.0 | 27.0 | 28.0 | 28.0 | 23.0 | 23.0 | 26.0 | 27.0 | 32.0 | 34.0 | 33.0 | 29.0 | 24.0 | 28.0 | 29.0 | 29.0 | 24.0 | 24.0 | 26.5 |
| 31 | 27.0 | 26.0 | 27.0 | 28.0 | 30.0 | 29.0 | 27.0 | 27.0 | 25.0 | 21.0 | 23.0 | 20.0 | 21.0 | 24.0 | 24.0 | 25.0 | 22.0 | 22.0 | 21.0 | 21.0 | 21.0 | 19.0 | 21.0 | 16.0 | 23.6 |
| AVG. | 14.6 | 15.3 | 14.9 | 15.8 | 16.3 | 16.3 | 15.6 | 15.6 | 15.8 | 16.4 | 15.9 | 15.6 | 16.5 | 17.2 | 17.9 | 17.4 | 16.2 | 16.4 | 15.4 | 15.0 | 14.9 | 15.4 | 15.6 | 14.8 | |

# of Valid Hours = 399 % Data Completeness = 53.6

# BISON ENGINEERING INC.
HELENA, MONTANA

FEBRUARY 1991

## *** *WIND SPEED SUMMARY* ***

HOURS

| DAY | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | AVG. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 13.0 | 15.0 | 15.0 | 14.0 | 23.0 | 24.0 | 19.0 | 26.0 | 25.0 | 25.0 | 22.0 | 21.0 | 23.0 | 25.0 | 21.0 | 18.0 | 16.0 | 14.0 | 12.0 | 23.0 | 21.0 | 24.0 | 24.0 | 25.0 | 20.3 |
| 2 | 21.0 | 21.0 | 22.0 | 21.0 | 22.0 | 25.0 | 26.0 | 27.0 | 27.0 | 28.0 | 26.0 | 26.0 | 26.0 | 24.0 | 22.0 | 20.0 | 20.0 | 21.0 | 19.0 | 21.0 | 18.0 | 16.0 | 18.0 | 18.0 | 22.3 |
| 3 | 19.0 | 19.0 | 18.0 | 16.0 | 15.0 | 16.0 | 18.0 | 16.0 | 17.0 | 16.0 | 16.0 | 15.0 | 17.0 | 18.0 | 14.0 | 13.0 | 9.0 | 8.0 | 13.0 | 13.0 | 18.0 | 15.0 | 17.0 | 16.0 | 15.5 |
| 4 | 17.0 | 20.0 | 17.0 | 17.0 | 15.0 | 16.0 | 15.0 | 15.0 | 15.0 | 16.0 | 21.0 | 25.0 | 27.0 | 25.0 | 22.0 | 21.0 | 24.0 | 25.0 | 28.0 | 28.0 | 24.0 | 24.0 | 29.0 | 27.0 | 21.4 |
| 5 | 25.0 | 27.0 | 27.0 | 24.0 | 23.0 | 21.0 | 20.0 | 16.0 | 15.0 | 16.0 | 14.0 | 15.0 | 12.0 | 11.0 | 14.0 | 17.0 | 17.0 | 14.0 | 10.0 | 10.0 | 12.0 | 9.0 | 5.0 | 4.0 | 15.8 |
| 6 | 5.0 | 6.0 | 4.0 | 3.0 | 2.0 | 2.0 | 2.0 | 2.0 | 1.0 | 2.0 | 13.0 | 12.0 | 6.0 | 6.0 | 6.0 | 7.0 | 6.0 | 5.0 | 7.0 | 7.0 | 4.0 | 4.0 | 6.0 | 10.0 | 5.3 |
| 7 | 13.0 | 17.0 | 17.0 | 17.0 | 15.0 | 19.0 | 23.0 | 23.0 | 23.0 | 26.0 | 20.0 | 22.0 | 19.0 | 17.0 | 14.0 | 16.0 | 15.0 | 15.0 | 12.0 | 11.0 | 14.0 | 15.0 | 15.0 | 15.0 | 17.2 |
| 8 | 16.0 | 14.0 | 15.0 | 14.0 | 15.0 | 13.0 | 15.0 | 14.0 | 17.0 | 16.0 | 14.0 | 15.0 | 15.0 | 14.0 | 11.0 | 12.0 | 6.0 | 3.0 | 6.0 | 4.0 | 6.0 | 4.0 | 7.0 | 11.0 | 11.5 |
| 9 | 11.0 | 9.0 | 11.0 | 12.0 | 11.0 | 11.0 | 10.0 | 14.0 | 11.0 | 13.0 | 14.0 | 7.0 | 8.0 | 6.0 | 4.0 | 4.0 | 6.0 | 2.0 | 6.0 | 9.0 | 4.0 | 4.0 | 3.0 | 3.0 | 8.0 |
| 10 | 5.0 | 6.0 | 7.0 | 11.0 | 12.0 | 13.0 | 15.0 | 15.0 | 21.0 | 21.0 | 16.0 | 14.0 | 14.0 | 14.0 | 14.0 | 14.0 | 12.0 | 11.0 | 8.0 | 10.0 | 8.0 | 7.0 | 7.0 | 9.0 | 11.8 |
| 11 | 12.0 | 9.0 | 14.0 | 13.0 | 12.0 | 11.0 | 16.0 | 20.0 | 22.0 | 22.0 | 17.0 | 20.0 | 22.0 | 18.0 | 15.0 | 15.0 | 13.0 | 11.0 | 12.0 | 12.0 | 15.0 | 15.0 | 14.0 | 16.0 | 15.3 |
| 12 | 17.0 | 19.0 | 17.0 | 13.0 | 20.0 | 18.0 | 16.0 | 13.0 | 14.0 | 18.0 | 17.0 | 24.0 | 20.0 | 17.0 | 22.0 | 18.0 | 21.0 | 15.0 | 9.0 | 15.0 | 15.0 | 13.0 | 13.0 | 16.0 | 16.7 |
| 13 | 12.0 | 15.0 | 17.0 | 13.0 | 14.0 | 13.0 | 15.0 | 13.0 | 15.0 | 16.0 | 17.0 | 13.0 | 14.0 | 12.0 | 17.0 | 17.0 | 17.0 | 12.0 | 10.0 | 10.0 | 10.0 | 10.0 | 11.0 | 10.0 | 13.5 |
| 14 | 10.0 | 13.0 | 13.0 | 10.0 | 8.0 | 11.0 | 14.0 | 14.0 | 9.0 | 7.0 | 9.0 | 13.0 | 11.0 | 7.0 | 5.0 | 6.0 | 5.0 | 8.0 | 6.0 | 5.0 | 10.0 | 9.0 | 9.0 | 10.0 | 9.3 |
| 15 | 12.0 | 14.0 | 13.0 | 12.0 | 13.0 | 14.0 | 17.0 | 17.0 | 18.0 | 23.0 | 21.0 | 18.0 | 16.0 | 11.0 | 16.0 | 17.0 | 14.0 | 18.0 | 18.0 | 20.0 | 17.0 | 17.0 | 17.0 | 17.0 | 16.3 |
| 16 | 14.0 | 12.0 | 8.0 | 8.0 | 9.0 | 9.0 | 11.0 | 12.0 | 9.0 | 10.0 | 9.0 | 9.0 | 9.0 | 6.0 | 5.0 | 5.0 | 8.0 | 12.0 | 11.0 | 8.0 | 7.0 | 6.0 | 4.0 | 8.0 | 8.7 |
| 17 | 11.0 | 12.0 | 9.0 | 7.0 | 9.0 | 10.0 | 11.0 | 13.0 | 14.0 | 12.0 | 11.0 | 13.0 | 13.0 | 15.0 | 14.0 | 15.0 | 12.0 | 10.0 | 8.0 | 5.0 | 7.0 | 10.0 | 11.0 | 10.0 | 10.9 |
| 18 | 14.0 | 13.0 | 9.0 | 9.0 | 6.0 | 11.0 | 12.0 | 12.0 | 10.0 | 12.0 | 13.0 | 17.0 | 15.0 | 18.0 | 18.0 | 15.0 | 12.0 | 10.0 | 9.0 | 10.0 | 9.0 | 9.0 | 8.0 | 9.0 | 11.7 |
| 19 | 11.0 | 14.0 | 16.0 | 19.0 | 21.0 | 22.0 | 20.0 | 21.0 | 16.0 | 20.0 | 20.0 | 23.0 | 33.0 | 30.0 | 26.0 | 26.0 | 25.0 | 23.0 | 24.0 | 22.0 | 24.0 | 21.0 | 18.0 | 21.0 | 21.5 |
| 20 | 21.0 | 19.0 | 20.0 | 22.0 | 24.0 | 25.0 | 27.0 | 30.0 | 27.0 | 20.0 | 21.0 | 21.0 | 23.0 | 24.0 | 17.0 | 18.0 | 20.0 | 20.0 | 22.0 | 17.0 | 13.0 | 12.0 | 16.0 | 12.0 | 20.5 |
| 21 | 10.0 | 11.0 | 13.0 | 14.0 | 15.0 | 9.0 | 12.0 | 8.0 | 18.0 | 18.0 | 20.0 | 16.0 | 17.0 | 16.0 | 17.0 | 16.0 | 11.0 | 9.0 | 3.0 | 5.0 | 11.0 | 9.0 | 7.0 | 5.0 | 12.1 |
| 22 | 6.0 | 7.0 | 8.0 | 7.0 | 5.0 | 1.0 | 1.0 | 1.0 | 1.0 | 9.0 | 14.0 | 13.0 | 12.0 | 14.0 | 16.0 | 16.0 | 14.0 | 13.0 | 6.0 | 6.0 | 20.0 | 16.0 | 6.0 | 6.0 | 9.1 |
| 23 | 5.0 | 5.0 | 4.0 | 2.0 | 2.0 | 2.0 | 2.0 | 1.0 | 1.0 | 6.0 | 16.0 | 19.0 | 19.0 | 17.0 | 17.0 | 17.0 | 11.0 | 8.0 | 7.0 | 10.0 | 14.0 | 11.0 | 19.0 | 10.0 | 9.4 |
| 24 | 9.0 | 6.0 | 5.0 | 3.0 | 3.0 | 3.0 | 3.0 | 6.0 | 4.0 | 5.0 | 9.0 | 10.0 | 12.0 | 14.0 | 17.0 | 17.0 | 18.0 | 13.0 | 11.0 | 11.0 | 11.0 | 11.0 | 9.0 | 4.0 | 8.9 |
| 25 | 5.0 | 2.0 | 8.0 | 13.0 | 12.0 | 13.0 | 14.0 | 13.0 | 11.0 | 8.0 | 13.0 | 13.0 | 11.0 | 12.0 | 10.0 | 9.0 | 7.0 | 4.0 | 6.0 | 5.0 | 7.0 | 9.0 | 9.0 | 10.0 | 9.3 |
| 26 | 12.0 | 14.0 | 9.0 | 10.0 | 12.0 | 13.0 | 16.0 | 16.0 | 22.0 | 21.0 | 15.0 | 13.0 | 10.0 | 11.0 | 15.0 | 14.0 | 13.0 | 8.0 | 4.0 | 7.0 | 7.0 | 8.0 | 9.0 | 6.0 | 11.9 |
| 27 | 6.0 | 9.0 | 10.0 | 10.0 | 8.0 | 8.0 | 6.0 | 9.0 | 4.0 | 4.0 | 4.0 | 7.0 | 14.0 | 16.0 | 11.0 | 15.0 | 13.0 | 10.0 | 8.0 | 6.0 | 6.0 | 11.0 | 11.0 | 17.0 | 9.3 |
| 28 | 18.0 | 15.0 | 17.0 | 17.0 | 16.0 | 18.0 | 17.0 | 12.0 | 13.0 | 11.0 | 18.0 | 19.0 | 23.0 | 16.0 | 20.0 | 22.0 | 23.0 | 20.0 | 21.0 | 20.0 | 20.0 | 17.0 | 18.0 | 18.0 | 17.9 |
| AVG. | 12.5 | 13.0 | 13.0 | 12.5 | 12.9 | 13.3 | 14.0 | 14.3 | 14.3 | 15.0 | 15.7 | 16.2 | 16.5 | 15.5 | 15.0 | 15.0 | 13.9 | 12.2 | 11.3 | 11.8 | 12.6 | 12.0 | 12.1 | 12.3 | |

# of Valid Hours = 672

% Data Completeness = 100.0

# BISON ENGINEERING INC.
## HELENA, MONTANA

MARCH 1991

## *** *WIND SPEED SUMMARY* ***

HOURS

| DAY | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | AVG. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 4 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 5 | - | - | - | - | - | - | - | - | - | - | 10.0 | 9.0 | 6.0 | 7.0 | 16.0 | 18.0 | 14.0 | 12.0 | 11.0 | 10.0 | 12.0 | 14.0 | 14.0 | 12.0 | 11.8 |
| 6 | 10.0 | 10.0 | 10.0 | 8.0 | 8.0 | 13.0 | 17.0 | 14.0 | 18.0 | 16.0 | 15.0 | 16.0 | 17.0 | 17.0 | 15.0 | 16.0 | 15.0 | 10.0 | 10.0 | 14.0 | 11.0 | 9.0 | 8.0 | 12.0 | 12.9 |
| 7 | 12.0 | 11.0 | 13.0 | 14.0 | 15.0 | 12.0 | 14.0 | 16.0 | 19.0 | 20.0 | 21.0 | 19.0 | 21.0 | 23.0 | 19.0 | 19.0 | 23.0 | 23.0 | 20.0 | 23.0 | 20.0 | 14.0 | 10.0 | 11.0 | 17.2 |
| 8 | 14.0 | 13.0 | 12.0 | 8.0 | 6.0 | 5.0 | 7.0 | 11.0 | 12.0 | 14.0 | 15.0 | 17.0 | 19.0 | 20.0 | 19.0 | 18.0 | 16.0 | 12.0 | 11.0 | 15.0 | 19.0 | 23.0 | 20.0 | 21.0 | 14.5 |
| 9 | 22.0 | 21.0 | 26.0 | 22.0 | 25.0 | 24.0 | 24.0 | 23.0 | 29.0 | 27.0 | 22.0 | 22.0 | 23.0 | 24.0 | 23.0 | 24.0 | 20.0 | 23.0 | 22.0 | 19.0 | 21.0 | 18.0 | 20.0 | 16.0 | 22.5 |
| 10 | 15.0 | 17.0 | 16.0 | 15.0 | 18.0 | 16.0 | 19.0 | 20.0 | 22.0 | 26.0 | 26.0 | 23.0 | 24.0 | 26.0 | 24.0 | 22.0 | 20.0 | 21.0 | 16.0 | 13.0 | 11.0 | 9.0 | 10.0 | 6.0 | 18.1 |
| 11 | 2.0 | 2.0 | 1.0 | 2.0 | 8.0 | 10.0 | 5.0 | 10.0 | 9.0 | 10.0 | 11.0 | 4.0 | 4.0 | 6.0 | 5.0 | 4.0 | 4.0 | 6.0 | 7.0 | 8.0 | 10.0 | 8.0 | 8.0 | 9.0 | 6.4 |
| 12 | 7.0 | 5.0 | 4.0 | 12.0 | 10.0 | 9.0 | 10.0 | 17.0 | 20.0 | 20.0 | 21.0 | 20.0 | 19.0 | 17.0 | 15.0 | 15.0 | 15.0 | 16.0 | 18.0 | 20.0 | 19.0 | 19.0 | 13.0 | 10.0 | 14.6 |
| 13 | 12.0 | 9.0 | 8.0 | 12.0 | 11.0 | 8.0 | 6.0 | 10.0 | 10.0 | 7.0 | 5.0 | 13.0 | 12.0 | 8.0 | 7.0 | 6.0 | 5.0 | 5.0 | 6.0 | 4.0 | 2.0 | 3.0 | 2.0 | 3.0 | 7.3 |
| 14 | 3.0 | 4.0 | 3.0 | 2.0 | 1.0 | 2.0 | 1.0 | 1.0 | 1.0 | 1.0 | 2.0 | 2.0 | 2.0 | 2.0 | 4.0 | 4.0 | 4.0 | 3.0 | 1.0 | 2.0 | 2.0 | 2.0 | 4.0 | 4.0 | 2.4 |
| 15 | 6.0 | 5.0 | 4.0 | 4.0 | 11.0 | 10.0 | 11.0 | 8.0 | 7.0 | 7.0 | 7.0 | 7.0 | 8.0 | 8.0 | 9.0 | 9.0 | 7.0 | 5.0 | 1.0 | 4.0 | 5.0 | 3.0 | 3.0 | 3.0 | 6.3 |
| 16 | 4.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 1.0 | 2.0 | 2.0 | 1.0 | 3.0 | 4.0 | 8.0 | 5.0 | 3.0 | 3.0 | 9.0 | 6.0 | 5.0 | 4.0 | 5.0 | 2.0 | 4.0 | 3.0 | 3.7 |
| 17 | 6.0 | 7.0 | 8.0 | 8.0 | 6.0 | 4.0 | 3.0 | 2.0 | 6.0 | 5.0 | 3.0 | 7.0 | 8.0 | 8.0 | 7.0 | 14.0 | 17.0 | 13.0 | 13.0 | 9.0 | 8.0 | 10.0 | 9.0 | 9.0 | 7.9 |
| 18 | 11.0 | 12.0 | 14.0 | 12.0 | 13.0 | 14.0 | 15.0 | 18.0 | 21.0 | 16.0 | 13.0 | 13.0 | 11.0 | 15.0 | 15.0 | 14.0 | 14.0 | 13.0 | 9.0 | 10.0 | 9.0 | 6.0 | 5.0 | 4.0 | 12.4 |
| 19 | 5.0 | 3.0 | 4.0 | 4.0 | 4.0 | 5.0 | 6.0 | 4.0 | 4.0 | 6.0 | 5.0 | 4.0 | 6.0 | 7.0 | 9.0 | 8.0 | 9.0 | 4.0 | 3.0 | 3.0 | 2.0 | 6.0 | 8.0 | 8.0 | 5.3 |
| 20 | 5.0 | 5.0 | 11.0 | 13.0 | 11.0 | 13.0 | 17.0 | 19.0 | 14.0 | 15.0 | 15.0 | 16.0 | 18.0 | 17.0 | 15.0 | 18.0 | 17.0 | 18.0 | 17.0 | 15.0 | 13.0 | 9.0 | 9.0 | 9.0 | 13.7 |
| 21 | 10.0 | 13.0 | 11.0 | 10.0 | 9.0 | 11.0 | 10.0 | 9.0 | 11.0 | 11.0 | 10.0 | 8.0 | 7.0 | 6.0 | 5.0 | 3.0 | 6.0 | 11.0 | 12.0 | 13.0 | 8.0 | 6.0 | 7.0 | 10.0 | 9.0 |
| 22 | 12.0 | 14.0 | 11.0 | 11.0 | 13.0 | 12.0 | 14.0 | 15.0 | 18.0 | 19.0 | 17.0 | 15.0 | 15.0 | 17.0 | 18.0 | 18.0 | 18.0 | 13.0 | 9.0 | 10.0 | 7.0 | 9.0 | 12.0 | 14.0 | 13.8 |
| 23 | 11.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 7.0 | 7.0 | 5.0 | 4.0 | 5.0 | 9.0 | 4.0 | 5.0 | 6.0 | 13.0 | 10.0 | 5.0 | 2.0 | 5.0 | 11.0 | 12.0 | 12.0 | 16.0 | 7.9 |
| 24 | 14.0 | 13.0 | 10.0 | 9.0 | 8.0 | 6.0 | 6.0 | 6.0 | 9.0 | 10.0 | 7.0 | 7.0 | 12.0 | 13.0 | 14.0 | 18.0 | 24.0 | 25.0 | 24.0 | 21.0 | 17.0 | 12.0 | 10.0 | 9.0 | 12.7 |
| 25 | 6.0 | 4.0 | 3.0 | 5.0 | 3.0 | 4.0 | 5.0 | 8.0 | 4.0 | 7.0 | 12.0 | 15.0 | 21.0 | 23.0 | 21.0 | 20.0 | 14.0 | 20.0 | 23.0 | 24.0 | 24.0 | 24.0 | 17.0 | 17.0 | 13.5 |
| 26 | 16.0 | 12.0 | 12.0 | 12.0 | 5.0 | 10.0 | 10.0 | 9.0 | 6.0 | 3.0 | 6.0 | 5.0 | 4.0 | 4.0 | 5.0 | 4.0 | 6.0 | 13.0 | 9.0 | 6.0 | 6.0 | 6.0 | 3.0 | 3.0 | 7.3 |
| 27 | 3.0 | 7.0 | 12.0 | 11.0 | 11.0 | 10.0 | 12.0 | 13.0 | 15.0 | 15.0 | 18.0 | 20.0 | 18.0 | 20.0 | 21.0 | 16.0 | 14.0 | 14.0 | 12.0 | 13.0 | 11.0 | 11.0 | 11.0 | 9.0 | 13.2 |
| 28 | 10.0 | 13.0 | 14.0 | 18.0 | 19.0 | 19.0 | 19.0 | 17.0 | 15.0 | 17.0 | 18.0 | 15.0 | 19.0 | 23.0 | 20.0 | 17.0 | 16.0 | 16.0 | 16.0 | 16.0 | 8.0 | 10.0 | 17.0 | 16.0 | 16.2 |
| 29 | 12.0 | 15.0 | 14.0 | 13.0 | 12.0 | 13.0 | 13.0 | 15.0 | 15.0 | 17.0 | 19.0 | 17.0 | 16.0 | 14.0 | 16.0 | 17.0 | 16.0 | 15.0 | 12.0 | 10.0 | 13.0 | 16.0 | 15.0 | 16.0 | 14.6 |
| 30 | 15.0 | 14.0 | 14.0 | 11.0 | 11.0 | 14.0 | 11.0 | 15.0 | 13.0 | 16.0 | 20.0 | 18.0 | 20.0 | 18.0 | 18.0 | 17.0 | 14.0 | 11.0 | 10.0 | 10.0 | 8.0 | 9.0 | 15.0 | 14.0 | 14.0 |
| 31 | 17.0 | 18.0 | 14.0 | 12.0 | 17.0 | 17.0 | 18.0 | 16.0 | 16.0 | 16.0 | 16.0 | 14.0 | 14.0 | 11.0 | 10.0 | 9.0 | 15.0 | 14.0 | 10.0 | 13.0 | 13.0 | 11.0 | 13.0 | 11.0 | 14.0 |
| AVG. | 10.0 | 9.9 | 10.0 | 10.0 | 10.2 | 10.5 | 10.8 | 11.7 | 12.3 | 12.5 | 12.7 | 12.6 | 13.2 | 13.5 | 13.3 | 13.5 | 13.4 | 12.9 | 11.4 | 11.6 | 10.9 | 10.4 | 10.3 | 10.2 | |

# of Valid Hours = 638 % Data Completeness = 85.8

# BISON ENGINEERING INC
## HELENA, MONTANA

Envircon Livingston, Montana 1ST QT '91

## *** *WIND FREQUENCY SUMMARY* ***

| DIR---><br>SPEED<br>(MPH) | N | NNE | NE | ENE | E | ESE | SE | SSE | S | SSW | SW | WSW | W | WNW | NW | NNW | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 - 4.0 | 1.4 | 2.3 | 1.0 | 0.4 | 0.4 | 0.4 | 0.0 | 0.2 | 0.3 | 0.9 | 0.7 | 0.4 | 0.6 | 0.2 | 0.8 | 1.0 | 10.7 |
| 4.0 - 7.5 | 1.1 | 1.4 | 0.6 | 0.6 | 0.1 | 0.2 | 0.0 | 0.0 | 0.1 | 0.5 | 1.5 | 1.9 | 0.8 | 0.4 | 0.4 | 0.6 | 10.1 |
| 7.5 - 12.1 | 1.4 | 1.1 | 0.1 | 1.4 | 0.3 | 0.1 | 0.0 | 0.0 | 0.1 | 1.8 | 7.4 | 7.8 | 2.7 | 0.4 | 0.2 | 0.8 | 25.5 |
| 12.1 - 19.0 | 0.8 | 0.1 | 0.1 | 1.2 | 0.7 | 0.0 | 0.0 | 0.0 | 0.0 | 4.4 | 11.5 | 9.4 | 6.8 | 0.2 | 0.2 | 0.2 | 35.4 |
| 19.0 - 24.7 | 0.0 | 0.0 | 0.0 | 0.6 | 0.8 | 0.0 | 0.0 | 0.0 | 0.0 | 3.3 | 5.9 | 1.7 | 1.4 | 0.0 | 0.0 | 0.0 | 13.6 |
| 24.7 - 30.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.8 | 1.8 | 0.7 | 0.0 | 0.0 | 0.0 | 0.0 | 4.3 |
| 30.0 - 40.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 0.1 | 0.0 | 0.0 | 0.0 | 0.4 |
| 40.0 - 50.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| OVER 50.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| TOTAL | 4.5 | 4.9 | 1.7 | 4.1 | 2.2 | 0.7 | 0.0 | 0.2 | 0.5 | 12.7 | 28.8 | 22.2 | 12.2 | 1.2 | 1.5 | 2.5 | |
| AVG. SPEED | 7.5 | 5.4 | 5.1 | 11.9 | 14.4 | 4.7 | 0.0 | 1.5 | 4.8 | 17.0 | 15.3 | 13.4 | 14.4 | 8.0 | 6.3 | 6.7 | |

Calm Hours = 0.0%

Total Hours With Both Speed and Direction = 1037

Average Wind Speed = 13.2 (MPH)

Resultant Windspeed = 9.3(MPH)

Resultant Wind Direction = 236.0Deg

Wind Persistance = 70.4 %

# BISON ENGINEERING INC.
HELENA, MONTANA

JANUARY 1991

## *** *WIND FREQUENCY SUMMARY* ***

| DIR---> <br>SPEED (MPH) | N | NNE | NE | ENE | E | ESE | SE | SSE | S | SSW | SW | WSW | W | WNW | NW | NNW | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 - 4.0 | 0.8 | 0.5 | 0.3 | 0.0 | 0.0 | 0.5 | 0.0 | 0.3 | 0.0 | 0.0 | 0.5 | 0.5 | 0.5 | 0.0 | 0.3 | 0.0 | 4.0 |
| 4.0 - 7.5 | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 0.0 | 0.8 | 1.8 | 0.0 | 0.3 | 0.3 | 1.0 | 4.5 |
| 7.5 - 12.1 | 1.3 | 1.5 | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 7.8 | 8.8 | 0.5 | 0.5 | 0.5 | 0.5 | 21.6 |
| 12.1 - 19.0 | 2.0 | 0.3 | 0.0 | 1.8 | 0.5 | 0.0 | 0.0 | 0.0 | 0.0 | 2.0 | 18.3 | 11.3 | 3.5 | 0.0 | 0.0 | 0.5 | 40.1 |
| 19.0 - 24.7 | 0.0 | 0.0 | 0.0 | 0.0 | 1.3 | 0.0 | 0.0 | 0.0 | 0.0 | 3.3 | 9.5 | 4.0 | 1.5 | 0.0 | 0.0 | 0.0 | 19.5 |
| 24.7 - 30.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.3 | 4.3 | 1.8 | 0.0 | 0.0 | 0.0 | 0.0 | 9.3 |
| 30.0 - 40.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.8 | 0.3 | 0.0 | 0.0 | 0.0 | 1.0 |
| 40.0 - 50.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| OVER 50.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| TOTAL | 4.3 | 2.3 | 0.5 | 1.8 | 1.8 | 0.5 | 0.0 | 0.3 | 0.3 | 8.5 | 41.1 | 28.8 | 6.3 | 0.8 | 1.0 | 2.0 | |
| AVG. SPEED | 10.6 | 9.7 | 6.0 | 15.9 | 19.9 | 4.0 | 0.0 | 2.0 | 5.0 | 22.7 | 16.9 | 14.8 | 16.5 | 8.0 | 7.3 | 8.9 | |

Calm Hours = 0.0%

Total Hours With Both Speed and Direction = 399

Average Wind Speed = 15.9 (MPH)

Resultant Windspeed = 12.5 (MPH)

Resultant Wind Direction = 233.9 Deg

Wind Persistance = 78.6 %

# BISON ENGINEERING INC.
## HELENA, MONTANA

## FEBRUARY 1991

### *** *WIND FREQUENCY SUMMARY* ***

| DIR---><br>SPEED<br>(MPH) | N | NNE | NE | ENE | E | ESE | SE | SSE | S | SSW | SW | WSW | W | WNW | NW | NNW | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 - 4.0 | 0.7 | 0.4 | 0.7 | 0.3 | 0.3 | 0.3 | 0.1 | 0.3 | 0.3 | 0.7 | 0.3 | 0.7 | 0.1 | 0.6 | 0.1 | 0.6 | 6.8 |
| 4.0 - 7.5 | 0.4 | 0.1 | 0.7 | 0.7 | 0.4 | 0.1 | 0.1 | 0.1 | 0.0 | 1.3 | 2.8 | 1.5 | 0.9 | 0.6 | 0.4 | 0.3 | 10.9 |
| 7.5 - 12.1 | 0.1 | 0.3 | 0.0 | 0.3 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 1.3 | 5.8 | 13.2 | 3.1 | 0.7 | 0.3 | 0.4 | 25.9 |
| 12.1 - 19.0 | 0.6 | 0.0 | 0.0 | 0.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 5.2 | 13.5 | 10.9 | 6.4 | 0.3 | 0.4 | 0.3 | 38.1 |
| 19.0 - 24.7 | 0.3 | 0.0 | 0.0 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.9 | 5.8 | 1.9 | 0.3 | 0.0 | 0.0 | 0.0 | 13.2 |
| 24.7 - 30.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.3 | 3.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 4.9 |
| 30.0 - 40.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 |
| 40.0 - 50.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| OVER 50.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| TOTAL | 2.2 | 0.9 | 1.5 | 2.8 | 0.9 | 0.4 | 0.3 | 0.4 | 0.3 | 14.0 | 31.8 | 28.3 | 10.9 | 2.2 | 1.3 | 1.6 | |
| AVG. SPEED | 9.8 | 5.0 | 4.4 | 13.2 | 5.3 | 4.0 | 4.5 | 3.7 | 3.5 | 16.6 | 16.0 | 12.4 | 13.3 | 7.5 | 9.1 | 7.5 | |

Calm Hours = 0.0%

Total Hours With Both Speed and Direction = 672

Average Wind Speed = 13.6 (MPH)

Resultant Windspeed = 11.1 (MPH)

Resultant Wind Direction = 234.4 Deg

Wind Persistance = 81.2 %

# BISON ENGINEERING INC.
HELENA, MONTANA

## MARCH 1991

## *** WIND FREQUENCY SUMMARY ***

| DIR---> SPEED (MPH) | N | NNE | NE | ENE | E | ESE | SE | SSE | S | SSW | SW | WSW | W | WNW | NW | NNW | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 - 4.0 | 1.7 | 3.4 | 1.4 | 0.6 | 0.6 | 0.3 | 0.0 | 0.2 | 0.5 | 1.4 | 0.8 | 0.3 | 0.6 | 0.3 | 1.1 | 1.6 | 14.9 |
| 4.0 - 7.5 | 1.6 | 2.4 | 0.9 | 0.9 | 0.2 | 0.3 | 0.0 | 0.0 | 0.0 | 0.8 | 2.0 | 2.0 | 1.3 | 0.5 | 0.5 | 0.3 | 13.6 |
| 7.5 - 12.1 | 1.4 | 0.8 | 0.0 | 2.2 | 0.5 | 0.2 | 0.0 | 0.0 | 0.2 | 3.0 | 7.2 | 7.2 | 4.1 | 0.3 | 0.0 | 0.9 | 27.9 |
| 12.1 - 19.0 | 0.0 | 0.0 | 0.2 | 0.8 | 0.8 | 0.0 | 0.0 | 0.0 | 0.0 | 6.0 | 7.2 | 8.2 | 8.8 | 0.3 | 0.3 | 0.0 | 32.4 |
| 19.0 - 24.7 | 0.0 | 0.0 | 0.0 | 0.9 | 0.5 | 0.0 | 0.0 | 0.0 | 0.0 | 3.3 | 3.6 | 0.3 | 1.3 | 0.0 | 0.0 | 0.0 | 9.9 |
| 24.7 - 30.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.9 | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.3 |
| 30.0 - 40.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 40.0 - 50.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| OVER 50.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| TOTAL | 4.7 | 6.6 | 2.5 | 5.5 | 2.5 | 0.8 | 0.0 | 0.2 | 0.6 | 15.4 | 21.2 | 18.0 | 16.0 | 1.4 | 1.9 | 2.8 | |
| AVG. SPEED | 5.8 | 4.5 | 4.9 | 11.1 | 12.0 | 5.0 | 0.0 | 1.0 | 4.8 | 15.0 | 13.4 | 12.0 | 13.8 | 8.0 | 6.0 | 5.7 | |

Calm Hours = 0.0%

Total Hours With Both Speed and Direction = 638

Average Wind Speed = 11.6 (MPH)

Resultant Windspeed = 7.4 (MPH)

Resultant Wind Direction = 238.2 Deg

Wind Persistance = 63.5 %

# BISON ENGINEERING INC.
## HELENA, MONTANA

JANUARY 1991

## *** *WIND DIRECTION SUMMARY* ***

HOURS

| DAY | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | AVG. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 4 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 5 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 6 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 7 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 8 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 9 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 10 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 11 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 12 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 13 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 14 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 15 | - | - | - | - | - | - | - | - | - | 227 | 217 | 232 | 239 | 253 | 253 | 251 | 252 | 248 | 285 | 238 | 234 | 226 | 257 | 263 | 245.2 |
| 16 | 266 | 253 | 253 | 263 | 285 | 250 | 238 | 233 | 238 | 248 | 241 | 242 | 261 | 262 | 270 | 253 | 255 | 243 | 248 | 244 | 243 | 232 | 238 | 248 | 252.8 |
| 17 | 238 | 240 | 225 | 228 | 233 | 227 | 224 | 213 | 229 | 229 | 214 | 228 | 225 | 225 | 227 | 222 | 236 | 226 | 216 | 226 | 236 | 226 | 222 | 223 | 224.6 |
| 18 | 225 | 243 | 250 | 246 | 249 | 229 | 221 | 236 | 227 | 235 | 234 | 233 | 225 | 222 | 214 | 215 | 209 | 211 | 220 | 213 | 212 | 209 | 209 | 212 | 207.2 |
| 19 | 217 | 344 | 359 | 9 | 14 | 26 | 357 | 114 | 258 | 313 | 254 | 265 | 263 | 265 | 263 | 263 | 252 | 249 | 242 | 253 | 245 | 239 | 234 | 228 | 206.9 |
| 20 | 234 | 232 | 248 | 250 | 259 | 246 | 232 | 248 | 243 | 244 | 233 | 230 | 229 | 233 | 221 | 225 | 242 | 242 | 235 | 237 | 243 | 228 | 230 | 227 | 336.7 |
| 21 | 238 | 238 | 240 | 237 | 232 | 234 | 232 | 235 | 234 | 221 | 218 | 215 | 212 | 217 | 217 | 223 | 226 | 229 | 224 | 220 | 220 | 236 | 220 | 206 | 328.9 |
| 22 | 212 | 218 | 221 | 230 | 204 | 220 | 221 | 219 | 218 | 218 | 214 | 224 | 225 | 230 | 239 | 252 | 233 | 241 | 232 | 239 | 246 | 328 | 188 | 230 | 331.2 |
| 23 | 331 | 308 | 22 | 1 | - | 303 | 332 | 305 | 1 | 239 | 258 | 249 | 230 | 220 | 224 | 228 | 229 | 219 | 229 | 234 | 239 | 246 | 246 | 236 | 335.1 |
| 24 | 253 | 220 | 210 | 219 | 237 | 235 | 226 | 233 | 240 | 334 | 347 | 354 | 36 | 11 | 13 | 5 | 14 | 359 | 3 | 32 | 34 | 46 | 344 | 281 | 337.1 |
| 25 | 216 | 221 | 3 | 19 | 3 | 114 | 324 | 235 | 230 | 222 | 220 | 225 | 230 | 235 | 239 | 222 | 240 | 247 | 253 | 242 | 234 | 251 | 244 | 229 | 336.3 |
| 26 | 226 | 237 | 235 | 255 | 239 | 235 | 235 | 235 | 245 | 229 | 227 | 240 | 228 | 239 | 275 | 266 | 251 | 254 | 261 | 252 | 249 | 251 | 259 | 255 | 326.3 |
| 27 | 260 | 244 | 255 | 264 | 258 | 274 | 274 | 261 | 269 | 273 | 280 | 258 | 258 | 258 | 263 | 257 | 257 | 239 | 249 | 218 | 228 | 227 | 218 | 222 | 264.0 |
| 28 | 332 | 75 | 68 | 65 | 59 | 76 | 67 | 81 | 89 | 88 | 87 | 87 | 97 | 86 | 76 | 34 | 2 | 3 | 5 | 351 | 258 | 163 | 234 | 225 | 79.2 |
| 29 | 227 | 223 | 234 | 228 | 222 | 225 | 223 | 221 | 221 | 220 | 218 | 216 | 223 | 230 | 245 | 237 | 253 | 265 | 256 | 242 | 247 | 242 | 253 | 238 | 82.7 |
| 30 | 218 | 232 | 235 | 235 | 233 | 229 | 233 | 224 | 223 | 232 | 236 | 252 | 252 | 242 | 248 | 242 | 241 | 239 | 238 | 209 | 199 | 210 | 230 | 219 | 122.0 |
| 31 | 220 | 220 | 213 | 205 | 210 | 213 | 214 | 216 | 219 | 209 | 211 | 208 | 213 | 220 | 215 | 213 | 221 | 211 | 216 | 208 | 209 | 210 | 209 | 221 | 204.1 |

# of Valid Hours =   398      % Data Completeness =  53.5

# BISON ENGINEERING INC.
HELENA, MONTANA

FEBRUARY 1991

## *** WIND DIRECTION SUMMARY ***

| DAY | HOURS 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | AVG. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 225 | 222 | 239 | 230 | 222 | 234 | 235 | 235 | 215 | 222 | 214 | 206 | 218 | 216 | 224 | 219 | 210 | 211 | 221 | 227 | 218 | 214 | 209 | 210 | 219.0 |
| 2 | 211 | 210 | 214 | 216 | 211 | 208 | 209 | 211 | 210 | 212 | 216 | 205 | 205 | 211 | 213 | 224 | 222 | 215 | 218 | 216 | 215 | 209 | 215 | 211 | 211.2 |
| 3 | 211 | 220 | 212 | 222 | 230 | 226 | 240 | 236 | 240 | 226 | 238 | 231 | 248 | 251 | 247 | 252 | 240 | 245 | 226 | 247 | 203 | 237 | 217 | 206 | 219.4 |
| 4 | 231 | 222 | 224 | 242 | 253 | 235 | 238 | 238 | 240 | 224 | 217 | 216 | 225 | 222 | 215 | 223 | 217 | 219 | 221 | 216 | 218 | 221 | 225 | 218 | 237.2 |
| 5 | 216 | 223 | 216 | 211 | 213 | 217 | 210 | 233 | 226 | 230 | 232 | 215 | 209 | 266 | 260 | 269 | 278 | 280 | 256 | 254 | 254 | 276 | 50 | 343 | 242.3 |
| 6 | 223 | 212 | 253 | 242 | 351 | 285 | 199 | 26 | 351 | 62 | 206 | 205 | 216 | 224 | 216 | 297 | 327 | 226 | 209 | 225 | 178 | 49 | 264 | 235 | 266.8 |
| 7 | 220 | 206 | 212 | 220 | 224 | 236 | 220 | 214 | 221 | 216 | 240 | 208 | 214 | 210 | 254 | 269 | 274 | 278 | 250 | 251 | 246 | 232 | 225 | 223 | 268.1 |
| 8 | 224 | 217 | 217 | 219 | 213 | 212 | 217 | 219 | 212 | 216 | 218 | 216 | 210 | 209 | 225 | 246 | 249 | 192 | 219 | 210 | 218 | 212 | 234 | 246 | 254.2 |
| 9 | 243 | 243 | 245 | 245 | 236 | 236 | 233 | 222 | 213 | 203 | 213 | 248 | 233 | 239 | 249 | 239 | 291 | 290 | 206 | 228 | 131 | 24 | 338 | 187 | 233.3 |
| 10 | 166 | 212 | 206 | 249 | 244 | 231 | 215 | 223 | 209 | 205 | 210 | 212 | 219 | 241 | 251 | 261 | 256 | 258 | 236 | 247 | 258 | 254 | 247 | 239 | 224.9 |
| 11 | 218 | 221 | 203 | 194 | 193 | 192 | 203 | 212 | 217 | 222 | 236 | 223 | 204 | 218 | 221 | 227 | 226 | 238 | 238 | 252 | 243 | 251 | 247 | 225 | 206.6 |
| 12 | 222 | 226 | 225 | 257 | 212 | 213 | 226 | 221 | 226 | 223 | 256 | 256 | 257 | 250 | 270 | 273 | 265 | 278 | 229 | 225 | 218 | 222 | 229 | 250 | 213.6 |
| 13 | 247 | 254 | 257 | 246 | 248 | 247 | 252 | 249 | 252 | 251 | 256 | 265 | 273 | 274 | 264 | 263 | 258 | 261 | 247 | 259 | 253 | 239 | 243 | 244 | 244.7 |
| 14 | 247 | 243 | 248 | 243 | 234 | 248 | 253 | 261 | 239 | 237 | 231 | 252 | 246 | 262 | 218 | 38 | 73 | 242 | 277 | 359 | 242 | 244 | 251 | 230 | 250.8 |
| 15 | 233 | 232 | 237 | 239 | 245 | 245 | 238 | 210 | 225 | 219 | 227 | 231 | 213 | 235 | 216 | 215 | 215 | 231 | 210 | 230 | 226 | 228 | 234 | 229 | 239.5 |
| 16 | 229 | 233 | 245 | 248 | 247 | 296 | 271 | 257 | 233 | 244 | 230 | 232 | 279 | 78 | 138 | 342 | 340 | 355 | 341 | 225 | 206 | 211 | 208 | 235 | 298.2 |
| 17 | 249 | 251 | 283 | 268 | 247 | 242 | 243 | 235 | 243 | 238 | 240 | 257 | 264 | 264 | 264 | 258 | 254 | 254 | 250 | 203 | 234 | 235 | 250 | 243 | 258.5 |
| 18 | 261 | 254 | 251 | 252 | 260 | 248 | 250 | 247 | 235 | 234 | 247 | 259 | 265 | 263 | 262 | 257 | 241 | 229 | 253 | 267 | 244 | 259 | 249 | 250 | 256.3 |
| 19 | 250 | 239 | 236 | 228 | 223 | 233 | 249 | 246 | 236 | 226 | 247 | 234 | 210 | 216 | 217 | 220 | 216 | 218 | 211 | 213 | 210 | 210 | 219 | 221 | 229.9 |
| 20 | 222 | 219 | 223 | 228 | 218 | 206 | 215 | 224 | 222 | 238 | 247 | 252 | 257 | 250 | 231 | 221 | 229 | 237 | 226 | 240 | 240 | 255 | 245 | 245 | 236.1 |
| 21 | 261 | 260 | 265 | 272 | 283 | 267 | 270 | 247 | 234 | 261 | 258 | 244 | 256 | 263 | 264 | 262 | 273 | 301 | 87 | 350 | 79 | 88 | 103 | 73 | 144.5 |
| 22 | 46 | 65 | 79 | 70 | 17 | 354 | 19 | 339 | 4 | 30 | 247 | 218 | 250 | 276 | 280 | 270 | 279 | 325 | 308 | 310 | 353 | 352 | 8 | 101 | 58.1 |
| 23 | 46 | 84 | 44 | 102 | 353 | 151 | 222 | 58 | 43 | 237 | 265 | 267 | 258 | 253 | 257 | 267 | 262 | 255 | 302 | 340 | 328 | 319 | 347 | 322 | 14.2 |
| 24 | 34 | 40 | 87 | 54 | 113 | 269 | 295 | 307 | 320 | 237 | 237 | 253 | 250 | 257 | 272 | 272 | 277 | 266 | 270 | 254 | 226 | 223 | 232 | 224 | 349.3 |
| 25 | 283 | 331 | 244 | 253 | 252 | 250 | 246 | 261 | 263 | 223 | 312 | 313 | 282 | 273 | 265 | 251 | 221 | 297 | 250 | 269 | 234 | 254 | 250 | 238 | 315.0 |
| 26 | 229 | 220 | 206 | 200 | 194 | 199 | 198 | 197 | 195 | 201 | 203 | 207 | 218 | 213 | 244 | 256 | 256 | 273 | 238 | 214 | 225 | 232 | 236 | 221 | 295.0 |
| 27 | 224 | 247 | 249 | 248 | 217 | 215 | 231 | 226 | 169 | 47 | 100 | 234 | 272 | 280 | 263 | 274 | 285 | 272 | 275 | 246 | 235 | 257 | 249 | 250 | 254.3 |
| 28 | 242 | 249 | 243 | 230 | 226 | 229 | 218 | 225 | 209 | 293 | 353 | - | 357 | 359 | 58 | 61 | 72 | 75 | 72 | 69 | 72 | 73 | 70 | 65 | 59.5 |

# of Valid Hours = 671     % Data Completeness = 99.9

# BISON ENGINEERING INC.
## HELENA, MONTANA

MARCH 1991

## *** *WIND DIRECTION SUMMARY* ***

HOURS

| DAY | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | AVG. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 4 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 5 | - | - | - | - | - | - | - | - | - | - | 257 | 213 | 287 | 277 | 257 | 260 | 262 | 250 | 224 | 235 | 239 | 244 | 249 | 258 | 249.2 |
| 6 | 265 | 261 | 260 | 261 | 241 | 233 | 227 | 221 | 212 | 243 | 245 | 266 | 273 | 265 | 266 | 265 | 262 | 260 | 268 | 277 | 267 | 261 | 257 | 264 | 257.9 |
| 7 | 272 | 260 | 261 | 256 | 249 | 238 | 228 | 230 | 224 | 226 | 222 | 226 | 258 | 263 | 256 | 234 | 224 | 226 | 217 | 218 | 210 | 232 | 205 | 214 | 239.6 |
| 8 | 232 | 236 | 233 | 253 | 215 | 297 | 260 | 278 | 248 | 251 | 262 | 260 | 258 | 254 | 260 | 252 | 260 | 259 | 231 | 222 | 214 | 211 | 209 | 215 | 233.2 |
| 9 | 215 | 216 | 213 | 212 | 212 | 221 | 223 | 223 | 225 | 221 | 209 | 218 | 222 | 214 | 225 | 223 | 224 | 218 | 216 | 201 | 194 | 205 | 206 | 212 | 218.5 |
| 10 | 215 | 208 | 211 | 213 | 203 | 216 | 206 | 205 | 204 | 212 | 214 | 202 | 211 | 202 | 206 | 214 | 223 | 230 | 213 | 196 | 203 | 252 | 344 | 315 | 208.1 |
| 11 | 262 | 122 | 93 | 78 | 355 | 2 | 34 | 4 | 21 | 20 | 352 | 280 | 185 | 251 | 268 | 262 | 185 | 216 | 240 | 227 | 238 | 239 | 247 | 235 | 259.2 |
| 12 | 225 | 267 | 198 | 212 | 234 | 189 | 204 | 218 | 209 | 212 | 215 | 211 | 222 | 220 | 233 | 248 | 248 | 238 | 223 | 216 | 214 | 213 | 219 | 210 | 290.5 |
| 13 | 212 | 216 | 233 | 213 | 220 | 215 | 207 | 222 | 217 | 202 | 32 | 208 | 203 | 106 | 50 | 16 | 73 | 51 | 24 | 5 | 213 | 346 | 23 | 350 | 337.7 |
| 14 | 43 | 14 | 32 | 26 | 164 | 15 | 222 | 19 | 25 | 30 | 25 | 95 | 64 | 350 | 6 | 320 | 331 | 342 | 9 | 202 | 194 | 188 | 241 | 219 | 344.5 |
| 15 | 237 | 226 | 293 | 215 | 233 | 231 | 225 | 237 | 228 | 219 | 224 | 322 | 5 | 17 | 356 | 350 | 10 | 21 | 24 | 218 | 196 | 207 | 326 | 23 | 341.9 |
| 16 | 340 | 54 | 19 | 20 | 26 | 348 | 26 | 349 | 86 | 15 | 51 | 358 | 292 | 329 | 113 | 69 | 349 | 326 | 279 | 325 | 52 | 5 | 203 | 206 | 334.6 |
| 17 | 215 | 249 | 242 | 246 | 266 | 44 | 44 | 212 | 247 | 248 | 357 | 7 | 11 | 34 | 24 | 266 | 263 | 259 | 257 | 260 | 245 | 234 | 234 | 240 | 346.4 |
| 18 | 241 | 240 | 242 | 237 | 225 | 215 | 201 | 198 | 203 | 209 | 208 | 207 | 212 | 211 | 211 | 229 | 223 | 221 | 209 | 206 | 209 | 122 | 25 | 27 | 206.1 |
| 19 | 10 | 28 | 29 | 8 | 25 | 9 | 31 | 31 | 43 | 56 | 29 | 348 | 31 | 57 | 59 | 63 | 69 | 89 | 321 | 201 | 227 | 215 | 223 | 227 | 52.2 |
| 20 | 209 | 198 | 250 | 229 | 234 | 234 | 230 | 237 | 220 | 235 | 236 | 243 | 263 | 258 | 225 | 204 | 212 | 218 | 214 | 211 | 216 | 245 | 216 | 214 | 218.4 |
| 21 | 222 | 227 | 234 | 219 | 225 | 215 | 220 | 221 | 213 | 214 | 216 | 219 | 215 | 254 | 2 | 333 | 260 | 259 | 261 | 269 | 249 | 224 | 247 | 243 | 229.7 |
| 22 | 254 | 258 | 253 | 245 | 259 | 270 | 277 | 283 | 276 | 266 | 252 | 262 | 260 | 273 | 268 | 264 | 270 | 274 | 276 | 288 | 234 | 253 | 236 | 250 | 266.7 |
| 23 | 268 | 243 | 232 | 236 | 250 | 239 | 237 | 258 | 241 | 250 | 293 | 332 | 313 | 348 | 37 | 311 | 22 | 16 | 67 | 78 | 71 | 69 | 70 | 88 | 43.9 |
| 24 | 70 | 79 | 74 | 88 | 88 | 34 | 69 | 24 | 60 | 82 | 82 | 74 | 66 | 69 | 41 | 218 | 201 | 204 | 206 | 210 | 212 | 234 | 243 | 236 | 74.5 |
| 25 | 242 | 31 | 320 | 215 | 340 | 358 | 239 | 61 | 36 | 33 | 62 | 74 | 75 | 73 | 87 | 78 | 98 | 76 | 79 | 85 | 79 | 81 | 80 | 80 | 75.5 |
| 26 | 80 | 78 | 63 | 336 | 356 | 343 | 341 | 354 | 5 | 50 | 7 | 10 | 353 | 53 | 48 | 332 | 104 | 76 | 72 | 72 | 33 | 3 | 289 | 319 | 71.9 |
| 27 | 262 | 281 | 242 | 236 | 231 | 245 | 272 | 278 | 276 | 259 | 252 | 260 | 263 | 263 | 260 | 253 | 268 | 265 | 239 | 245 | 262 | 266 | 256 | 264 | 268.3 |
| 28 | 269 | 261 | 255 | 270 | 279 | 272 | 281 | 272 | 263 | 264 | 261 | 252 | 260 | 267 | 273 | 268 | 257 | 254 | 295 | 310 | 229 | 268 | 276 | 253 | 269.8 |
| 29 | 249 | 254 | 252 | 250 | 251 | 257 | 257 | 265 | 262 | 269 | 261 | 256 | 256 | 266 | 263 | 247 | 244 | 242 | 249 | 250 | 242 | 243 | 248 | 245 | 259.6 |
| 30 | 252 | 250 | 250 | 236 | 233 | 218 | 230 | 217 | 210 | 248 | 276 | 272 | 276 | 279 | 269 | 281 | 277 | 268 | 267 | 264 | 246 | 251 | 229 | 221 | 261.8 |
| 31 | 241 | 219 | 229 | 224 | 217 | 216 | 202 | 205 | 202 | 204 | 206 | 208 | 210 | 200 | 222 | 230 | 211 | 224 | 207 | 207 | 207 | 222 | 228 | 241 | 211.5 |

# of Valid Hours =   638      % Data Completeness =  85.8

# BISON ENGINEERING INC.
## HELENA, MONTANA

Envirocon Livingston, Montana JANUARY 1991

### *** *WIND SIGMA SUMMARY (DEGREES)* ***

HOURS

| DAY | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | AVG. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0 |
| 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0 |
| 3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0 |
| 4 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0 |
| 5 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0 |
| 6 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0 |
| 7 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0 |
| 8 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0 |
| 9 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0 |
| 10 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0 |
| 11 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0 |
| 12 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0 |
| 13 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0 |
| 14 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0 |
| 15 | - | - | - | - | - | - | - | - | - | 21 | 13 | 19 | 14 | 10 | 9 | 11 | 9 | 15 | 30 | 33 | 20 | 18 | 10 | 11 | 16 |
| 16 | 69 | 12 | 19 | 16 | 37 | 13 | 11 | 20 | 14 | 16 | 16 | 21 | 9 | 10 | 10 | 11 | 12 | 13 | 10 | 18 | 15 | 11 | 13 | 16 | 17 |
| 17 | 18 | 16 | 12 | 13 | 13 | 14 | 15 | 10 | 16 | 12 | 12 | 17 | 16 | 14 | 16 | 12 | 13 | 13 | 12 | 16 | 15 | 16 | 13 | 17 | 14 |
| 18 | 18 | 15 | 14 | 14 | 14 | 15 | 14 | 15 | 12 | 17 | 15 | 16 | 15 | 13 | 12 | 15 | 14 | 14 | 17 | 20 | 12 | 11 | 10 | 12 | 14 |
| 19 | 13 | 42 | 24 | 17 | 15 | 22 | 51 | 48 | 43 | 22 | 14 | 9 | 9 | 9 | 8 | 8 | 10 | 16 | 23 | 26 | 12 | 14 | 15 | 15 | 20 |
| 20 | 14 | 9 | 10 | 9 | 7 | 12 | 12 | 10 | 18 | 14 | 10 | 14 | 13 | 14 | 12 | 14 | 10 | 12 | 17 | 11 | 12 | 10 | 13 | 10 | 12 |
| 21 | 11 | 12 | 11 | 13 | 11 | 15 | 11 | 13 | 14 | 11 | 11 | 10 | 11 | 11 | 10 | 11 | 11 | 11 | 10 | 12 | 16 | 17 | 13 | 13 | 12 |
| 22 | 10 | 11 | 13 | 19 | 17 | 13 | 15 | 18 | 14 | 13 | 12 | 15 | 15 | 13 | 20 | 18 | 15 | 11 | 11 | 14 | 26 | 41 | 79 | 14 | 19 |
| 23 | 23 | 57 | 46 | 11 | 11 | 42 | 52 | 57 | 48 | 60 | 20 | 13 | 15 | 15 | 13 | 11 | 13 | 11 | 11 | 12 | 12 | 20 | 16 | 17 | 25 |
| 24 | 18 | 20 | 15 | 20 | 20 | 19 | 17 | 20 | 27 | 37 | 18 | 25 | 28 | 15 | 15 | 11 | 11 | 14 | 12 | 12 | 17 | 46 | 15 | 80 | 22 |
| 25 | 26 | 54 | 31 | 34 | 56 | 78 | 90 | 10 | 12 | 11 | 10 | 11 | 12 | 12 | 15 | 12 | 19 | 13 | 19 | 14 | 11 | 45 | 15 | 12 | 26 |
| 26 | 11 | 15 | 16 | 16 | 12 | 10 | 15 | 16 | 15 | 11 | 12 | 13 | 14 | 16 | 9 | 12 | 10 | 10 | 8 | 11 | 10 | 10 | 7 | 11 | 12 |
| 27 | 9 | 14 | 13 | 9 | 12 | 9 | 8 | 11 | 10 | 8 | 13 | 14 | 12 | 14 | 11 | 16 | 17 | 20 | 22 | 14 | 18 | 15 | 14 | 18 | 13 |
| 28 | 45 | 11 | 12 | 14 | 14 | 10 | 10 | 10 | 9 | 9 | 9 | 10 | 13 | 12 | 16 | 21 | 10 | 12 | 17 | 41 | 69 | 67 | 14 | 10 | 19 |
| 29 | 11 | 11 | 13 | 12 | 11 | 11 | 11 | 11 | 10 | 10 | 11 | 13 | 14 | 15 | 16 | 14 | 16 | 17 | 21 | 26 | 24 | 21 | 23 | 23 | 15 |
| 30 | 21 | 22 | 18 | 14 | 15 | 17 | 17 | 17 | 14 | 17 | 19 | 15 | 16 | 16 | 13 | 13 | 16 | 15 | 20 | 12 | 14 | 18 | 17 | 17 | 16 |
| 31 | 17 | 14 | 12 | 12 | 12 | 11 | 12 | 10 | 12 | 12 | 13 | 14 | 13 | 13 | 12 | 12 | 12 | 12 | 11 | 12 | 14 | 17 | 13 | 15 | 13 |
| AVG. | 21 | 21 | 17 | 15 | 17 | 19 | 23 | 19 | 18 | 18 | 13 | 15 | 14 | 13 | 13 | 13 | 13 | 13 | 16 | 18 | 19 | 23 | 18 | 18 | |

# BISON ENGINEERING INC.
## HELENA, MONTANA

Envirocon Livingston, Montana FEBRUARY 1991

### * * * WIND SIGMA SUMMARY (DEGREES) * * *

| DAY | HOURS 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | AVG. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 24 | 18 | 17 | 21 | 14 | 21 | 18 | 16 | 14 | 16 | 15 | 14 | 18 | 12 | 16 | 12 | 13 | 11 | 16 | 12 | 12 | 9 | 11 | 11 | 15 |
| 2 | 10 | 11 | 11 | 13 | 12 | 11 | 11 | 11 | 10 | 10 | 10 | 12 | 11 | 12 | 13 | 15 | 12 | 11 | 14 | 12 | 12 | 13 | 13 | 12 | 12 |
| 3 | 14 | 14 | 15 | 16 | 18 | 24 | 23 | 17 | 16 | 11 | 14 | 15 | 13 | 12 | 15 | 14 | 21 | 16 | 18 | 27 | 11 | 22 | 12 | 11 | 16 |
| 4 | 18 | 17 | 17 | 18 | 14 | 17 | 14 | 17 | 20 | 15 | 12 | 12 | 13 | 13 | 13 | 15 | 13 | 12 | 14 | 14 | 17 | 15 | 16 | 13 | 15 |
| 5 | 12 | 14 | 13 | 11 | 12 | 16 | 14 | 17 | 15 | 13 | 16 | 19 | 16 | 13 | 16 | 9 | 8 | 8 | 18 | 10 | 8 | 28 | 66 | 48 | 18 |
| 6 | 31 | 24 | 73 | 74 | 65 | 72 | 63 | 53 | 28 | 38 | 31 | 14 | 33 | 33 | 27 | 63 | 32 | 31 | 10 | 11 | 78 | 63 | 53 | 40 | 43 |
| 7 | 30 | 9 | 8 | 11 | 12 | 12 | 11 | 11 | 15 | 11 | 18 | 11 | 11 | 13 | 25 | 9 | 8 | 8 | 28 | 11 | 9 | 12 | 10 | 11 | 13 |
| 8 | 13 | 12 | 12 | 14 | 12 | 12 | 13 | 13 | 11 | 12 | 13 | 11 | 11 | 12 | 26 | 10 | 80 | 30 | 31 | 55 | 23 | 29 | 19 | 10 | 20 |
| 9 | 12 | 11 | 9 | 10 | 11 | 14 | 13 | 10 | 15 | 12 | 12 | 28 | 14 | 19 | 23 | 23 | 67 | 55 | 16 | 14 | 72 | 56 | 56 | 71 | 27 |
| 10 | 69 | 45 | 52 | 10 | 11 | 16 | 12 | 12 | 12 | 11 | 12 | 10 | 13 | 18 | 18 | 10 | 9 | 8 | 25 | 9 | 13 | 34 | 29 | 16 | 20 |
| 11 | 11 | 21 | 13 | 14 | 15 | 18 | 11 | 10 | 9 | 14 | 22 | 17 | 13 | 12 | 14 | 13 | 9 | 14 | 16 | 20 | 16 | 20 | 20 | 21 | 15 |
| 12 | 17 | 13 | 18 | 22 | 12 | 12 | 18 | 20 | 23 | 16 | 14 | 10 | 16 | 18 | 17 | 11 | 16 | 24 | 25 | 15 | 12 | 12 | 13 | 10 | 16 |
| 13 | 10 | 10 | 9 | 10 | 10 | 9 | 10 | 10 | 10 | 9 | 10 | 17 | 20 | 38 | 26 | 15 | 9 | 10 | 13 | 13 | 18 | 9 | 10 | 10 | 13 |
| 14 | 9 | 9 | 9 | 13 | 13 | 11 | 11 | 16 | 13 | 12 | 15 | 20 | 21 | 46 | 61 | 22 | 55 | 21 | 79 | 85 | 9 | 13 | 17 | 14 | 25 |
| 15 | 14 | 11 | 11 | 13 | 13 | 14 | 14 | 12 | 17 | 14 | 20 | 18 | 15 | 20 | 16 | 13 | 11 | 16 | 18 | 16 | 14 | 14 | 18 | 15 | 15 |
| 16 | 16 | 16 | 15 | 19 | 15 | 34 | 16 | 13 | 15 | 13 | 16 | 23 | 51 | 61 | 21 | 52 | 23 | 10 | 15 | 28 | 13 | 12 | 31 | 16 | 23 |
| 17 | 10 | 10 | 25 | 38 | 13 | 12 | 16 | 12 | 9 | 10 | 16 | 10 | 12 | 12 | 12 | 11 | 11 | 10 | 11 | 45 | 19 | 11 | 14 | 15 | 15 |
| 18 | 9 | 12 | 11 | 14 | 42 | 14 | 9 | 13 | 17 | 14 | 12 | 11 | 12 | 13 | 10 | 12 | 15 | 12 | 17 | 10 | 14 | 11 | 14 | 14 | 14 |
| 19 | 15 | 13 | 13 | 15 | 14 | 14 | 15 | 16 | 17 | 17 | 15 | 18 | 14 | 22 | 15 | 15 | 17 | 17 | 16 | 19 | 15 | 20 | 13 | 16 | 16 |
| 20 | 15 | 15 | 17 | 14 | 12 | 11 | 12 | 12 | 12 | 17 | 15 | 14 | 14 | 12 | 16 | 15 | 14 | 13 | 12 | 13 | 13 | 16 | 14 | 15 | 14 |
| 21 | 19 | 16 | 14 | 12 | 8 | 12 | 11 | 26 | 15 | 12 | 11 | 15 | 16 | 13 | 11 | 11 | 19 | 53 | 56 | 19 | 18 | 18 | 19 | 27 | 19 |
| 22 | 14 | 20 | 14 | 22 | 18 | 14 | 27 | 34 | 50 | 86 | 17 | 21 | 32 | 16 | 11 | 12 | 14 | 32 | 35 | 33 | 21 | 29 | 57 | 58 | 29 |
| 23 | 45 | 22 | 30 | 53 | 33 | 72 | 72 | 62 | 34 | 60 | 13 | 12 | 14 | 13 | 13 | 10 | 13 | 12 | 41 | 14 | 10 | 35 | 13 | 71 | 32 |
| 24 | 68 | 33 | 47 | 62 | 76 | 70 | 69 | 26 | 33 | 50 | 28 | 19 | 21 | 21 | 10 | 11 | 9 | 9 | 8 | 20 | 11 | 12 | 17 | 71 | 33 |
| 25 | 48 | 69 | 13 | 13 | 10 | 12 | 10 | 9 | 22 | 48 | 25 | 23 | 30 | 27 | 29 | 29 | 27 | 14 | 32 | 64 | 24 | 8 | 8 | 15 | 25 |
| 26 | 13 | 13 | 16 | 13 | 15 | 13 | 12 | 14 | 11 | 11 | 12 | 14 | 14 | 14 | 25 | 13 | 11 | 14 | 52 | 21 | 13 | 8 | 13 | 23 | 16 |
| 27 | 40 | 12 | 9 | 15 | 24 | 24 | 21 | 18 | 48 | 58 | 67 | 18 | 15 | 10 | 13 | 11 | 11 | 18 | 21 | 26 | 16 | 13 | 14 | 21 | 23 |
| 28 | 18 | 17 | 16 | 11 | 10 | 11 | 10 | 15 | 13 | 64 | 13 | 14 | 16 | 16 | 21 | 11 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 9 | 15 |
| 29 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0 |
| 30 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0 |
| 31 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0 |
| AVG. | 22 | 18 | 19 | 20 | 19 | 21 | 20 | 18 | 19 | 24 | 18 | 16 | 18 | 19 | 19 | 17 | 20 | 18 | 24 | 23 | 19 | 20 | 21 | 24 | |

# BISON ENGINEERING INC.
## HELENA, MONTANA

Envirocon Livingston, Montana MARCH 1991

### *** WIND SIGMA SUMMARY (DEGREES) ***

HOURS

| DAY | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | AVG. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0 |
| 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0 |
| 3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0 |
| 4 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0 |
| 5 | - | - | - | - | - | - | - | - | - | - | 13 | 16 | 65 | 40 | 11 | 10 | 9 | 11 | 9 | 13 | 10 | 12 | 10 | 7 | 17 |
| 6 | 8 | 10 | 9 | 11 | 13 | 15 | 12 | 14 | 13 | 18 | 21 | 9 | 8 | 9 | 13 | 10 | 10 | 15 | 12 | 11 | 11 | 11 | 12 | 13 | 12 |
| 7 | 12 | 15 | 11 | 12 | 12 | 14 | 12 | 12 | 14 | 14 | 14 | 18 | 10 | 9 | 11 | 18 | 13 | 12 | 14 | 13 | 14 | 22 | 26 | 16 | 14 |
| 8 | 16 | 11 | 15 | 14 | 17 | 57 | 24 | 17 | 21 | 13 | 12 | 12 | 13 | 12 | 11 | 14 | 10 | 11 | 19 | 12 | 13 | 11 | 14 | 12 | 16 |
| 9 | 15 | 17 | 13 | 14 | 12 | 11 | 12 | 12 | 11 | 12 | 15 | 14 | 13 | 13 | 12 | 11 | 12 | 11 | 11 | 12 | 11 | 13 | 11 | 13 | 13 |
| 10 | 13 | 11 | 14 | 13 | 11 | 13 | 10 | 10 | 12 | 12 | 12 | 13 | 14 | 12 | 12 | 13 | 12 | 12 | 17 | 17 | 15 | 55 | 18 | 45 | 16 |
| 11 | 80 | 56 | 37 | 58 | 19 | 16 | 19 | 14 | 32 | 17 | 11 | 53 | 29 | 41 | 19 | 30 | 34 | 20 | 21 | 19 | 15 | 19 | 10 | 12 | 28 |
| 12 | 15 | 42 | 80 | 18 | 50 | 62 | 31 | 16 | 12 | 13 | 12 | 12 | 15 | 14 | 14 | 13 | 12 | 16 | 14 | 14 | 12 | 11 | 18 | 28 | 23 |
| 13 | 17 | 24 | 30 | 15 | 17 | 39 | 41 | 29 | 13 | 61 | 65 | 17 | 12 | 81 | 13 | 15 | 15 | 15 | 22 | 62 | 43 | 25 | 23 | 19 | 30 |
| 14 | 21 | 19 | 21 | 55 | 47 | 33 | 77 | 63 | 32 | 24 | 31 | 25 | 61 | 29 | 30 | 15 | 17 | 20 | 33 | 47 | 46 | 21 | 27 | 24 | 34 |
| 15 | 50 | 27 | 82 | 70 | 11 | 14 | 12 | 13 | 19 | 19 | 17 | 65 | 12 | 19 | 13 | 13 | 15 | 17 | 77 | 25 | 16 | 41 | 58 | 32 | 31 |
| 16 | 13 | 35 | 26 | 30 | 27 | 41 | 27 | 19 | 67 | 30 | 30 | 18 | 36 | 52 | 38 | 61 | 13 | 18 | 26 | 70 | 29 | 72 | 14 | 33 | 34 |
| 17 | 24 | 19 | 13 | 14 | 50 | 53 | 59 | 56 | 13 | 23 | 66 | 14 | 15 | 16 | 44 | 13 | 9 | 13 | 10 | 14 | 23 | 16 | 16 | 10 | 25 |
| 18 | 11 | 10 | 11 | 13 | 14 | 13 | 12 | 12 | 12 | 12 | 11 | 13 | 16 | 17 | 16 | 16 | 17 | 14 | 16 | 14 | 24 | 74 | 53 | 39 | 19 |
| 19 | 28 | 40 | 43 | 22 | 22 | 20 | 29 | 28 | 35 | 31 | 42 | 26 | 27 | 20 | 19 | 21 | 13 | 31 | 68 | 61 | 49 | 20 | 16 | 16 | 30 |
| 20 | 50 | 49 | 11 | 16 | 13 | 16 | 22 | 18 | 15 | 16 | 20 | 20 | 9 | 9 | 17 | 12 | 11 | 15 | 13 | 13 | 12 | 19 | 16 | 12 | 18 |
| 21 | 11 | 10 | 11 | 10 | 14 | 12 | 10 | 11 | 11 | 10 | 10 | 15 | 18 | 55 | 23 | 41 | 25 | 9 | 7 | 8 | 24 | 23 | 15 | 12 | 16 |
| 22 | 11 | 10 | 10 | 10 | 9 | 8 | 8 | 8 | 9 | 12 | 12 | 13 | 18 | 13 | 14 | 13 | 11 | 11 | 7 | 10 | 31 | 10 | 12 | 18 | 12 |
| 23 | 10 | 21 | 20 | 18 | 17 | 27 | 15 | 11 | 21 | 41 | 77 | 29 | 47 | 50 | 27 | 35 | 15 | 22 | 59 | 25 | 12 | 10 | 12 | 10 | 26 |
| 24 | 13 | 12 | 14 | 16 | 16 | 27 | 29 | 12 | 17 | 13 | 25 | 28 | 12 | 12 | 25 | 62 | 11 | 11 | 10 | 10 | 12 | 13 | 13 | 14 | 18 |
| 25 | 60 | 40 | 61 | 27 | 84 | 78 | 64 | 23 | 23 | 13 | 19 | 13 | 12 | 11 | 17 | 13 | 24 | 10 | 9 | 10 | 9 | 10 | 10 | 11 | 27 |
| 26 | 10 | 11 | 39 | 14 | 37 | 13 | 12 | 16 | 20 | 56 | 24 | 38 | 56 | 48 | 56 | 61 | 35 | 11 | 10 | 13 | 13 | 14 | 56 | 73 | 31 |
| 27 | 71 | 34 | 18 | 15 | 11 | 16 | 14 | 17 | 14 | 11 | 11 | 12 | 13 | 13 | 11 | 13 | 14 | 16 | 10 | 11 | 10 | 12 | 10 | 13 | 16 |
| 28 | 10 | 9 | 11 | 17 | 10 | 8 | 9 | 10 | 9 | 12 | 16 | 21 | 16 | 13 | 13 | 12 | 12 | 32 | 18 | 56 | 70 | 18 | 11 | 10 | 18 |
| 29 | 10 | 8 | 10 | 11 | 11 | 8 | 9 | 8 | 10 | 9 | 12 | 11 | 12 | 15 | 18 | 15 | 13 | 12 | 11 | 13 | 11 | 12 | 12 | 10 | 11 |
| 30 | 10 | 11 | 10 | 12 | 16 | 13 | 12 | 12 | 14 | 24 | 11 | 12 | 12 | 15 | 13 | 11 | 14 | 10 | 8 | 11 | 22 | 10 | 10 | 16 | 13 |
| 31 | 11 | 10 | 15 | 15 | 13 | 13 | 10 | 11 | 11 | 13 | 16 | 14 | 14 | 24 | 26 | 27 | 14 | 13 | 13 | 11 | 11 | 14 | 15 | 22 | 15 |
| AVG. | 23 | 22 | 24 | 21 | 22 | 25 | 23 | 18 | 18 | 20 | 23 | 20 | 22 | 25 | 20 | 22 | 15 | 15 | 20 | 22 | 21 | 22 | 19 | 20 |  |

# BISON ENGINEERING INC.
## HELENA, MONTANA

Envirocon Livingston, Montana JANUARY 1991

### *** *TEMPERATURE SUMMARY (DEG F)* ***

| DAY | HOURS 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | AVG. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0 |
| 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0 |
| 3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0 |
| 4 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0 |
| 5 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0 |
| 6 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0 |
| 7 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0 |
| 8 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0 |
| 9 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0 |
| 10 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0 |
| 11 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0 |
| 12 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0 |
| 13 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0 |
| 14 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0 |
| 15 | - | - | - | - | - | - | - | - | - | 37 | 37 | 37 | 39 | 39 | 39 | 39 | 37 | 37 | 37 | 36 | 36 | 36 | 36 | 36 | 37 |
| 16 | 34 | 34 | 32 | 32 | 32 | 34 | 32 | 32 | 32 | 34 | 34 | 36 | 36 | 37 | 36 | 37 | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 34 |
| 17 | 36 | 36 | 36 | 34 | 34 | 34 | 34 | 34 | 36 | 36 | 37 | 37 | 39 | 39 | 39 | 37 | 39 | 39 | 39 | 37 | 37 | 37 | 37 | 37 | 37 |
| 18 | 37 | 37 | 37 | 37 | 36 | 37 | 37 | 37 | 37 | 39 | 41 | 43 | 46 | 46 | 46 | 46 | 45 | 43 | 43 | 41 | 41 | 41 | 41 | 41 | 41 |
| 19 | 41 | 34 | 28 | 21 | 19 | 19 | 18 | 19 | 19 | 18 | 19 | 19 | 19 | 19 | 21 | 21 | 21 | 19 | 19 | 18 | 19 | 21 | 21 | 21 | 22 |
| 20 | 19 | 19 | 19 | 18 | 19 | 19 | 19 | 19 | 19 | 21 | 21 | 23 | 25 | 25 | 25 | 25 | 25 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 22 |
| 21 | 23 | 21 | 19 | 19 | 19 | 18 | 16 | 16 | 16 | 18 | 19 | 19 | 23 | 25 | 25 | 28 | 28 | 30 | 30 | 30 | 32 | 32 | 30 | 30 | 24 |
| 22 | 30 | 30 | 30 | 30 | 27 | 27 | 25 | 25 | 25 | 25 | 27 | 27 | 28 | 28 | 30 | 30 | 28 | 28 | 27 | 27 | 28 | 28 | 27 | 25 | 28 |
| 23 | 25 | 25 | 25 | 23 | 21 | 19 | 19 | 19 | 18 | 21 | 23 | 23 | 25 | 25 | 25 | 25 | 23 | 21 | 21 | 23 | 23 | 25 | 27 | 27 | 23 |
| 24 | 27 | 27 | 28 | 28 | 28 | 27 | 25 | 25 | 25 | 25 | 23 | 23 | 23 | 21 | 21 | 19 | 18 | 16 | 14 | 12 | 10 | 10 | 9 | 5 | 20 |
| 25 | 1 | -0 | -2 | -4 | -4 | -2 | -2 | 3 | 5 | 7 | 10 | 10 | 14 | 14 | 16 | 16 | 14 | 12 | 10 | 10 | 10 | 9 | 9 | 10 | 7 |
| 26 | 10 | 10 | 10 | 9 | 10 | 10 | 12 | 12 | 14 | 16 | 16 | 19 | 21 | 21 | 23 | 23 | 25 | 25 | 25 | 23 | 21 | 21 | 21 | 21 | 18 |
| 27 | 21 | 21 | 21 | 21 | 21 | 23 | 21 | 21 | 21 | 21 | 23 | 25 | 28 | 30 | 30 | 32 | 32 | 30 | 30 | 28 | 28 | 28 | 27 | 25 | 25 |
| 28 | 25 | 19 | 16 | 14 | 12 | 10 | 10 | 9 | 7 | 7 | 7 | 7 | 7 | 7 | 5 | 3 | 1 | -2 | -4 | -6 | -9 | -11 | -6 | -6 | 5 |
| 29 | -6 | -6 | -4 | -6 | -4 | -2 | -2 | -0 | 1 | 3 | 7 | 10 | 14 | 16 | 18 | 19 | 19 | 19 | 19 | 19 | 18 | 18 | 16 | 16 | 8 |
| 30 | 18 | 18 | 18 | 18 | 19 | 19 | 19 | 21 | 23 | 25 | 27 | 28 | 30 | 30 | 30 | 30 | 30 | 30 | 32 | 34 | 34 | 34 | 34 | 36 | 27 |
| 31 | 34 | 34 | 34 | 34 | 34 | 32 | 34 | 34 | 36 | 39 | 39 | 41 | 43 | 45 | 46 | 48 | 46 | 46 | 45 | 45 | 43 | 41 | 41 | 41 | 40 |
| AVG. | 23 | 22 | 22 | 21 | 20 | 20 | 20 | 20 | 21 | 23 | 24 | 25 | 27 | 28 | 28 | 28 | 28 | 27 | 26 | 26 | 25 | 25 | 25 | 25 | |

MINIMUM T = -11 MAXIMUM T = 48 AVERAGE T = 24 HOURS OF DATA = 399

# BISON ENGINEERING INC.
HELENA, MONTANA

Envirocon Livingston, Montana FEBRUARY 1991

## *** TEMPERATURE SUMMARY (DEG F) ***

HOURS

| DAY | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | AVG. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 41 | 43 | 43 | 41 | 41 | 41 | 39 | 39 | 41 | 43 | 43 | 46 | 48 | 50 | 52 | 52 | 52 | 50 | 50 | 50 | 50 | 48 | 48 | 46 | 46 |
| 2 | 48 | 48 | 45 | 45 | 45 | 43 | 43 | 43 | 45 | 45 | 48 | 52 | 54 | 55 | 55 | 55 | 54 | 52 | 50 | 50 | 48 | 46 | 46 | 45 | 48 |
| 3 | 45 | 45 | 45 | 45 | 43 | 41 | 41 | 41 | 41 | 43 | 45 | 46 | 50 | 50 | 52 | 50 | 50 | 48 | 46 | 45 | 45 | 43 | 43 | 43 | 45 |
| 4 | 41 | 41 | 39 | 39 | 39 | 39 | 37 | 39 | 41 | 43 | 46 | 48 | 48 | 50 | 50 | 50 | 50 | 48 | 46 | 46 | 46 | 46 | 45 | 45 | 44 |
| 5 | 45 | 45 | 45 | 45 | 45 | 45 | 43 | 43 | 43 | 45 | 48 | 52 | 54 | 54 | 54 | 52 | 50 | 48 | 46 | 45 | 43 | 43 | 39 | 37 | 46 |
| 6 | 36 | 34 | 34 | 32 | 27 | 25 | 23 | 21 | 25 | 32 | 39 | 43 | 46 | 48 | 50 | 50 | 48 | 43 | 37 | 34 | 32 | 30 | 37 | 43 | 36 |
| 7 | 43 | 41 | 41 | 39 | 39 | 39 | 41 | 39 | 41 | 41 | 45 | 48 | 52 | 57 | 59 | 59 | 57 | 54 | 50 | 48 | 48 | 46 | 46 | 45 | 47 |
| 8 | 45 | 43 | 43 | 41 | 39 | 39 | 39 | 37 | 39 | 39 | 43 | 45 | 48 | 52 | 54 | 54 | 52 | 50 | 46 | 45 | 43 | 41 | 41 | 39 | 44 |
| 9 | 39 | 37 | 37 | 36 | 36 | 37 | 37 | 37 | 39 | 41 | 45 | 48 | 48 | 52 | 55 | 55 | 55 | 52 | 45 | 41 | 37 | 34 | 32 | 30 | 42 |
| 10 | 30 | 32 | 32 | 34 | 34 | 36 | 37 | 37 | 37 | 37 | 41 | 45 | 48 | 52 | 54 | 55 | 54 | 50 | 45 | 43 | 43 | 41 | 37 | 37 | 41 |
| 11 | 39 | 39 | 39 | 39 | 39 | 39 | 37 | 37 | 39 | 41 | 45 | 48 | 54 | 57 | 59 | 59 | 57 | 54 | 52 | 50 | 50 | 50 | 48 | 48 | 47 |
| 12 | 48 | 46 | 46 | 45 | 46 | 46 | 46 | 45 | 45 | 45 | 45 | 43 | 45 | 46 | 46 | 46 | 45 | 41 | 39 | 39 | 39 | 39 | 39 | 39 | 44 |
| 13 | 39 | 39 | 39 | 39 | 39 | 39 | 39 | 37 | 37 | 37 | 39 | 41 | 41 | 41 | 43 | 43 | 43 | 41 | 41 | 39 | 39 | 39 | 39 | 39 | 40 |
| 14 | 39 | 39 | 39 | 39 | 37 | 39 | 37 | 37 | 37 | 39 | 39 | 43 | 45 | 43 | 45 | 39 | 39 | 43 | 41 | 39 | 43 | 43 | 43 | 45 | 41 |
| 15 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 45 | 45 | 46 | 50 | 54 | 55 | 57 | 57 | 57 | 55 | 54 | 52 | 50 | 50 | 48 | 48 | 48 | 49 |
| 16 | 48 | 48 | 46 | 45 | 45 | 43 | 41 | 41 | 43 | 45 | 46 | 48 | 48 | 46 | 48 | 48 | 46 | 41 | 37 | 34 | 34 | 34 | 36 | 36 | 43 |
| 17 | 36 | 36 | 34 | 34 | 32 | 32 | 30 | 30 | 32 | 32 | 34 | 36 | 36 | 37 | 37 | 37 | 37 | 36 | 34 | 34 | 34 | 32 | 34 | 32 | 34 |
| 18 | 32 | 32 | 30 | 30 | 30 | 28 | 28 | 28 | 30 | 30 | 34 | 34 | 36 | 37 | 37 | 37 | 37 | 36 | 34 | 34 | 32 | 32 | 32 | 30 | 33 |
| 19 | 30 | 32 | 32 | 32 | 32 | 34 | 34 | 36 | 36 | 37 | 37 | 41 | 43 | 43 | 45 | 46 | 48 | 46 | 46 | 46 | 46 | 46 | 48 | 48 | 40 |
| 20 | 50 | 50 | 48 | 48 | 48 | 46 | 46 | 45 | 46 | 46 | 50 | 52 | 52 | 54 | 52 | 52 | 52 | 50 | 48 | 48 | 48 | 50 | 50 | 50 | 49 |
| 21 | 48 | 48 | 48 | 46 | 46 | 43 | 43 | 43 | 46 | 48 | 48 | 50 | 50 | 50 | 52 | 50 | 50 | 48 | 46 | 41 | 37 | 36 | 34 | 32 | 45 |
| 22 | 30 | 28 | 27 | 27 | 25 | 23 | 21 | 23 | 25 | 36 | 46 | 52 | 55 | 55 | 55 | 57 | 55 | 50 | 46 | 45 | 41 | 36 | 34 | 32 | 39 |
| 23 | 30 | 30 | 28 | 28 | 27 | 25 | 23 | 23 | 27 | 34 | 37 | 37 | 39 | 41 | 41 | 43 | 43 | 43 | 39 | 37 | 37 | 36 | 30 | 28 | 34 |
| 24 | 28 | 27 | 25 | 25 | 25 | 25 | 23 | 21 | 23 | 27 | 30 | 32 | 34 | 36 | 36 | 37 | 37 | 36 | 34 | 34 | 36 | 36 | 36 | 36 | 31 |
| 25 | 36 | 34 | 36 | 36 | 34 | 36 | 34 | 34 | 34 | 34 | 36 | 37 | 37 | 37 | 39 | 39 | 39 | 39 | 36 | 30 | 30 | 30 | 30 | 30 | 35 |
| 26 | 30 | 30 | 30 | 28 | 28 | 27 | 27 | 27 | 27 | 28 | 32 | 34 | 39 | 41 | 45 | 46 | 46 | 45 | 39 | 34 | 32 | 30 | 28 | 28 | 33 |
| 27 | 28 | 30 | 30 | 32 | 34 | 32 | 32 | 32 | 34 | 34 | 36 | 37 | 37 | 37 | 39 | 41 | 41 | 41 | 39 | 37 | 36 | 37 | 36 | 36 | 35 |
| 28 | 36 | 37 | 37 | 37 | 37 | 36 | 36 | 36 | 37 | 39 | 37 | 37 | 32 | 30 | 28 | 25 | 21 | 18 | 18 | 16 | 14 | 12 | 12 | 10 | 28 |
| 29 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0 |
| 30 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0 |
| 31 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0 |
| AVG. | 39 | 38 | 38 | 37 | 37 | 36 | 36 | 36 | 37 | 39 | 42 | 44 | 45 | 47 | 48 | 48 | 47 | 45 | 42 | 40 | 40 | 39 | 38 | 38 | |

MINIMUM T = 10 MAXIMUM T = 59 AVERAGE T = 41 HOURS OF DATA = 672

# BISON ENGINEERING INC.
## HELENA, MONTANA

RAILYARD LIVINGSTON MARCH

### *** *TEMPERATURE SUMMARY (DEG F)* ***

HOURS

| DAY | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | AVG. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0 |
| 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0 |
| 3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0 |
| 4 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0 |
| 5 | - | - | - | - | - | - | - | - | - | - | 32 | 32 | 34 | 32 | 32 | 32 | 30 | 30 | 28 | 27 | 27 | 25 | 23 | 21 | 29 |
| 6 | 18 | 18 | 18 | 21 | 21 | 23 | 21 | 23 | 25 | 25 | 25 | 27 | 27 | 28 | 30 | 30 | 30 | 28 | 28 | 27 | 25 | 25 | 25 | 27 | 25 |
| 7 | 27 | 27 | 25 | 25 | 27 | 25 | 25 | 25 | 27 | 28 | 32 | 34 | 34 | 34 | 36 | 36 | 34 | 34 | 34 | 34 | 34 | 32 | 28 | 28 | 30 |
| 8 | 30 | 28 | 28 | 28 | 27 | 27 | 27 | 28 | 28 | 32 | 32 | 34 | 36 | 37 | 39 | 41 | 41 | 41 | 37 | 37 | 37 | 36 | 36 | 36 | 34 |
| 9 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 36 | 37 | 41 | 45 | 46 | 48 | 50 | 48 | 48 | 48 | 46 | 45 | 45 | 45 | 45 | 43 | 41 |
| 10 | 43 | 43 | 43 | 39 | 39 | 39 | 39 | 43 | 45 | 48 | 48 | 52 | 52 | 52 | 52 | 52 | 50 | 48 | 46 | 45 | 43 | 41 | 36 | 34 | 45 |
| 11 | 32 | 32 | 32 | 32 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 34 | 36 | 34 | 34 | 36 | 36 | 34 | 30 | 27 | 25 | 25 | 25 | 21 | 31 |
| 12 | 23 | 21 | 19 | 25 | 23 | 25 | 28 | 28 | 30 | 34 | 36 | 37 | 39 | 41 | 41 | 41 | 41 | 39 | 36 | 36 | 34 | 34 | 32 | 32 | 32 |
| 13 | 32 | 32 | 32 | 32 | 32 | 34 | 34 | 34 | 34 | 37 | 43 | 43 | 45 | 45 | 41 | 41 | 41 | 39 | 37 | 34 | 34 | 32 | 30 | 28 | 36 |
| 14 | 28 | 27 | 25 | 25 | 25 | 21 | 21 | 19 | 21 | 27 | 34 | 37 | 41 | 41 | 39 | 41 | 41 | 39 | 37 | 34 | 32 | 30 | 30 | 30 | 31 |
| 15 | 30 | 30 | 27 | 27 | 30 | 30 | 30 | 32 | 32 | 36 | 39 | 41 | 39 | 41 | 41 | 41 | 41 | 41 | 37 | 36 | 34 | 32 | 30 | 28 | 34 |
| 16 | 28 | 28 | 27 | 25 | 25 | 23 | 21 | 23 | 27 | 30 | 36 | 37 | 37 | 39 | 43 | 41 | 37 | 37 | 36 | 36 | 34 | 32 | 30 | 28 | 32 |
| 17 | 28 | 30 | 32 | 32 | 32 | 30 | 30 | 30 | 34 | 36 | 39 | 37 | 39 | 39 | 41 | 41 | 37 | 36 | 36 | 34 | 34 | 34 | 34 | 32 | 34 |
| 18 | 32 | 32 | 30 | 30 | 30 | 30 | 28 | 30 | 30 | 34 | 39 | 43 | 48 | 52 | 54 | 55 | 55 | 54 | 52 | 50 | 46 | 45 | 39 | 36 | 41 |
| 19 | 34 | 32 | 32 | 30 | 30 | 28 | 30 | 30 | 36 | 41 | 45 | 46 | 52 | 52 | 54 | 55 | 55 | 54 | 50 | 46 | 45 | 41 | 41 | 39 | 42 |
| 20 | 39 | 37 | 41 | 43 | 43 | 43 | 45 | 45 | 46 | 46 | 46 | 46 | 46 | 46 | 48 | 45 | 43 | 43 | 41 | 41 | 41 | 41 | 37 | 36 | 43 |
| 21 | 36 | 36 | 34 | 34 | 34 | 34 | 34 | 34 | 36 | 36 | 36 | 37 | 39 | 43 | 45 | 45 | 45 | 43 | 41 | 39 | 39 | 37 | 37 | 36 | 38 |
| 22 | 37 | 37 | 37 | 36 | 36 | 36 | 36 | 36 | 36 | 37 | 39 | 39 | 43 | 43 | 45 | 45 | 45 | 45 | 43 | 41 | 37 | 37 | 39 | 39 | 39 |
| 23 | 39 | 37 | 34 | 34 | 34 | 32 | 32 | 36 | 39 | 41 | 43 | 45 | 46 | 46 | 46 | 43 | 39 | 39 | 39 | 37 | 34 | 34 | 34 | 32 | 38 |
| 24 | 32 | 32 | 32 | 32 | 32 | 30 | 30 | 30 | 30 | 32 | 34 | 37 | 39 | 41 | 43 | 48 | 48 | 46 | 45 | 43 | 41 | 41 | 39 | 36 | 37 |
| 25 | 34 | 32 | 30 | 30 | 30 | 32 | 34 | 30 | 30 | 34 | 37 | 41 | 43 | 43 | 43 | 41 | 37 | 32 | 30 | 30 | 28 | 28 | 28 | 28 | 34 |
| 26 | 28 | 27 | 25 | 19 | 18 | 16 | 16 | 16 | 18 | 25 | 23 | 27 | 28 | 30 | 34 | 34 | 34 | 32 | 30 | 28 | 27 | 25 | 23 | 25 | 25 |
| 27 | 25 | 27 | 28 | 28 | 28 | 27 | 27 | 28 | 30 | 30 | 32 | 32 | 34 | 36 | 37 | 37 | 39 | 39 | 37 | 37 | 37 | 37 | 36 | 34 | 33 |
| 28 | 32 | 32 | 30 | 32 | 32 | 32 | 32 | 34 | 37 | 41 | 43 | 43 | 45 | 45 | 46 | 46 | 45 | 43 | 39 | 36 | 36 | 36 | 34 | 30 | 37 |
| 29 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 32 | 34 | 36 | 37 | 39 | 41 | 43 | 43 | 43 | 45 | 43 | 41 | 41 | 39 | 39 | 37 | 36 |
| 30 | 37 | 36 | 36 | 34 | 34 | 32 | 32 | 34 | 37 | 39 | 43 | 45 | 46 | 48 | 50 | 52 | 54 | 54 | 50 | 48 | 45 | 45 | 46 | 45 | 42 |
| 31 | 43 | 43 | 41 | 41 | 43 | 41 | 41 | 43 | 45 | 48 | 52 | 57 | 59 | 63 | 64 | 64 | 64 | 64 | 61 | 57 | 55 | 54 | 52 | 50 | 52 |
| AVG. | 32 | 32 | 31 | 31 | 31 | 30 | 30 | 31 | 33 | 35 | 38 | 39 | 41 | 42 | 43 | 43 | 43 | 42 | 40 | 38 | 37 | 36 | 34 | 33 | |

MINIMUM T = 16 MAXIMUM T = 64 AVERAGE T = 36 HOURS OF DATA = 638

# APPENDIX B

# QUALITY ASSURANCE/QUALITY CONTROL

## *CERTIFICATION OF DATA INTEGRITY*

Bison Engineering Inc. certifies that the data contained herein are, to the best of our knowledge, an accurate summary of air quality and meteorological conditions measured at the Livingston Railyard in Livingston, MT. Every effort was made to obtain accurate and representative data and to comply with procedures set forth in the Quality Assurance Handbook for Air Pollution Measurement Systems; Volume II, Ambient Air Specific Methods (EPA-600/4-77-027a) and the conditions of Section 14.4 of the Interim Remedial Measures Work Plan (work plan) as required by the Montana Department of Health and Environmental Sciences.

Project Manager: Harold W Robb

Title: Vice President

Date: February 28, 1991

# BISON ENGINEERING INC

Helena, Montana

## PM-10 Calibration - Wedding Assoc.

Calibrated by Scott F and Dan M Location Livingston

Date March 29, 1991 Sampler # Upwind - #3

Look-up :

20" U-Tube Manometer: 21.1 " Water = delta

Barometric Pressure : 25.3 " " Mercury = P0

Temperature: 40 F

P1/P0 = 0.939 {P1=P0 - delta/13.6

Look-up = 39.173 = Look-ACFM

Look-SCFM = 35.578 (std ft^3/min)

= ACFM[P0*298]/29.92*Tk] Tk=temp degrees K

Orifice:

10 " Manometer 4.3 " (Clean Filter)

$$Q = .49134\ (dP)^{.49610}$$

= 1.013 (m^3/min)

Qcfm = Q*35.314

= 35.776 (acfm)r

$$Qscfm = Qcfm[(P0*298)/(29.92*Tk)]^{0.5}$$

= 34.095

% Difference: 4.4 %

Adjustment: N/A (if necessary)

Clean Filter Transducer: --- acfm

# BISON ENGINEERING INC

Helena, Montana

## PM-10 Calibration - Wedding Assoc.

Calibrated by Scott F and Dan M Location Livingston

Date March 29, 1991 Sampler # Downwind #4

Look-up :

20" U-Tube Manometer: 21.3 " Water = delta

Barometric Pressure : 25.3 " " Mercury = P0

Temperature: 40 F

P1/P0 = 0.938 {P1=P0 - delta/13.6

Look-up = 38.825 = Look-ACFM

Look-SCFM = 35.262 (std ft^3/min)

= ACFM[P0*298]/29.92*Tk] Tk=temp degrees K

Orifice:

10 " Manometer 4.1 " (Clean Filter)

$$Q = .49134\ (dP)^{.49610}$$

= 1.001 (m^3/min)

Qcfm = Q*35.314

= 35.361 (acfm)r

$$Qscfm = Qcfm[(P0*298)/(29.92*Tk)]^{0.5}$$

= 33.699

% Difference: 4.6 %

Adjustment: N/A (if necessary)

~~Clean Filter Transducer: --- acfm~~

# BISON ENGINEERING INC

Helena, Montana

PM-10 Auditing - Wedding Assoc.

Audited by Scott Fitzpatrick Location Livingston

Date March 29, 1991 Sampler # Upwind #3

Look-up :

P1/P0 = 0.939 (from previous calibration)

Temperature: 40 F (degrees K)

Look-up = 39.173 = Look-ACFM

Look-SCFM = 35.135 (std ft^3/min)

= ACFM[P0*298]/29.92*Tk] Tk=temp degrees K

Audit Orifice

10 " Manometer 2.7 " (Clean Filter)

$$Q = .62283\ (dP)^{.48645}$$

= 1.010 (m^3/min)

Qcfm = Q*35.314

= 35.658 (acfm)r

$$Qscfm = Qcfm[(P0*298)/(29.92*Tk)]^{0.5}$$

= 33.881

$$Qacfm = Qcfm[(P0*298)/(29.92*Tk)]^{-0.5} = 37.528$$

Clean Filter Trans. ---

% Difference: 3.7 % (from SCFM)

% Difference: -6.7 % (from 40 ACFM)

# BISON ENGINEERING INC

Helena, Montana

PM-10 Auditing - Wedding Assoc.

Audited by Scott Fitzpatrick Location Livingston

Date March 29, 1991 Sampler # Downwind #4

Look-up :

P1/P0 = 0.938 (from previous calibration)

Temperature: 40 F (degrees K)

Look-up = 38.825 = Look-ACFM

Look-SCFM = 35.052 (std ft^3/min)

= ACFM[P0*298]/29.92*Tk] Tk=temp degrees K

Audit Orifice

10 " Manometer 2.7 " (Clean Filter)

$$Q = .62283\,(dP)^{.48645}$$

= 1.010 (m^3/min)

Qcfm = Q*35.314

= 35.658 (acfm)r

$$Qscfm = Qcfm[(P0*298)/(29.92*Tk)]^{0.5}$$

= 33.881

$$Qacfm = Qcfm[(P0*298)/(29.92*Tk)]^{-0.5} = 37.528$$

Clean Filter Trans. ---

% Difference: 3.5 % (from SCFM)

% Difference: -6.7 % (from 40 ACFM)

# BISON ENGINEERING INC

Helena, Montana

## Total Suspended Particulate - Calibration

Envirocon

Calibrated by Scott F and Dan M Location Livingston

Date March 29, 1991 Sampler # Downwind #4

Calibration Equation: $Qr = .49134\ (dP)^{.49610}$

| Run | Plate No. | P1 (left) | P2 (right) | dP (total) | TR | $Qr^{*}$ | $Qr^{+}$ |
|---|---|---|---|---|---|---|---|
| 1 | 18 | 4.2 | 4.1 | 8.3 | 45 | 1.404 | 1.387 |
| 2 | 13 | 3.0 | 2.9 | 5.9 | 38 | 1.185 | 1.189 |
| 3 | 10 | 2.7 | 2.7 | 5.4 | 36 | 1.134 | 1.129 |
| 4 | 7 | 1.8 | 1.8 | 3.6 | 30 | 0.928 | 0.951 |
| 5 | 5 | 1.1 | 1.1 | 2.2 | 22 | 0.727 | 0.713 |

$Qr^{*}$ = flow rate by Orifice equation

$Qr^{+}$ = flow rate from transducer regression equation

Results--

Slope = 0.29747 Intercept = 0.05815 Corr. Coeff. = 0.9985

$Qr = a(TR) + b =$ 0.029747 (TR) + 0.05815

# BISON ENGINEERING INC

Helena, Montana

## Total Suspended Particulate - Audit

Audited by Scott Fitzpatrick Company Envirocon

Date 3/29/91 Project Livingston Railyard

Audit Equation: $Qr = .62283\ (dP)^{.48645}$

| Sample # | Plate No. | P1 (left) | P2 (right) | dP (total) | TR | $Qr^*$ | $Qr^+$ |
|---|---|---|---|---|---|---|---|
| 4 | 18 | 1.8 | 1.8 | 3.6 | 39 | 1.162 | 1.092 |
| | 18 | | | | | | |
| | 18 | | | | | | |
| | 18 | | | | | | |
| | 18 | | | | | | |

$Qr^*$ = flow rate by Audit Equation

$Qr^+$ = flow rate from previous calibration equation

Results:

| Sampler # | % Difference |
|---|---|
| 4 | -5.9 % |
| | % |
| | % |
| | % |
| | % |